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ROM

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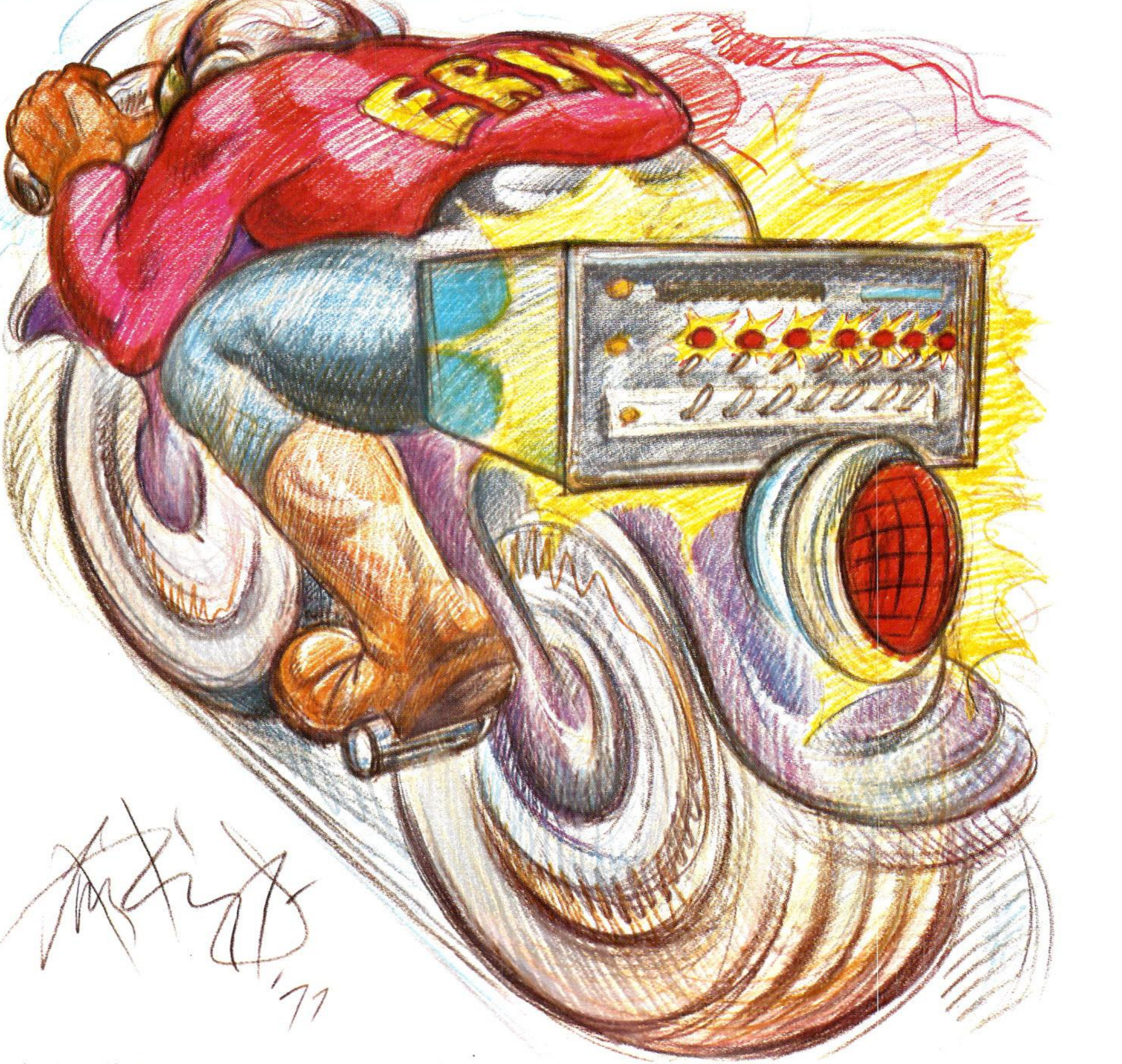

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*   Scrolling or page mode operation
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*   Reversed character printing
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                 keyboard
                 serial interface  (110-1200 baud)
                 chassis and cover
                 cursor control
                 complete control character decoding
                 beeper
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Meeting the diversified demands of an ever-increasing microprocessor market requires flexibility: not just hardware flexibility but software flexibility as well. MITS software, including the innovative Altair BASIC language, allows the full potential of the Altair 8800b computer to be realized.

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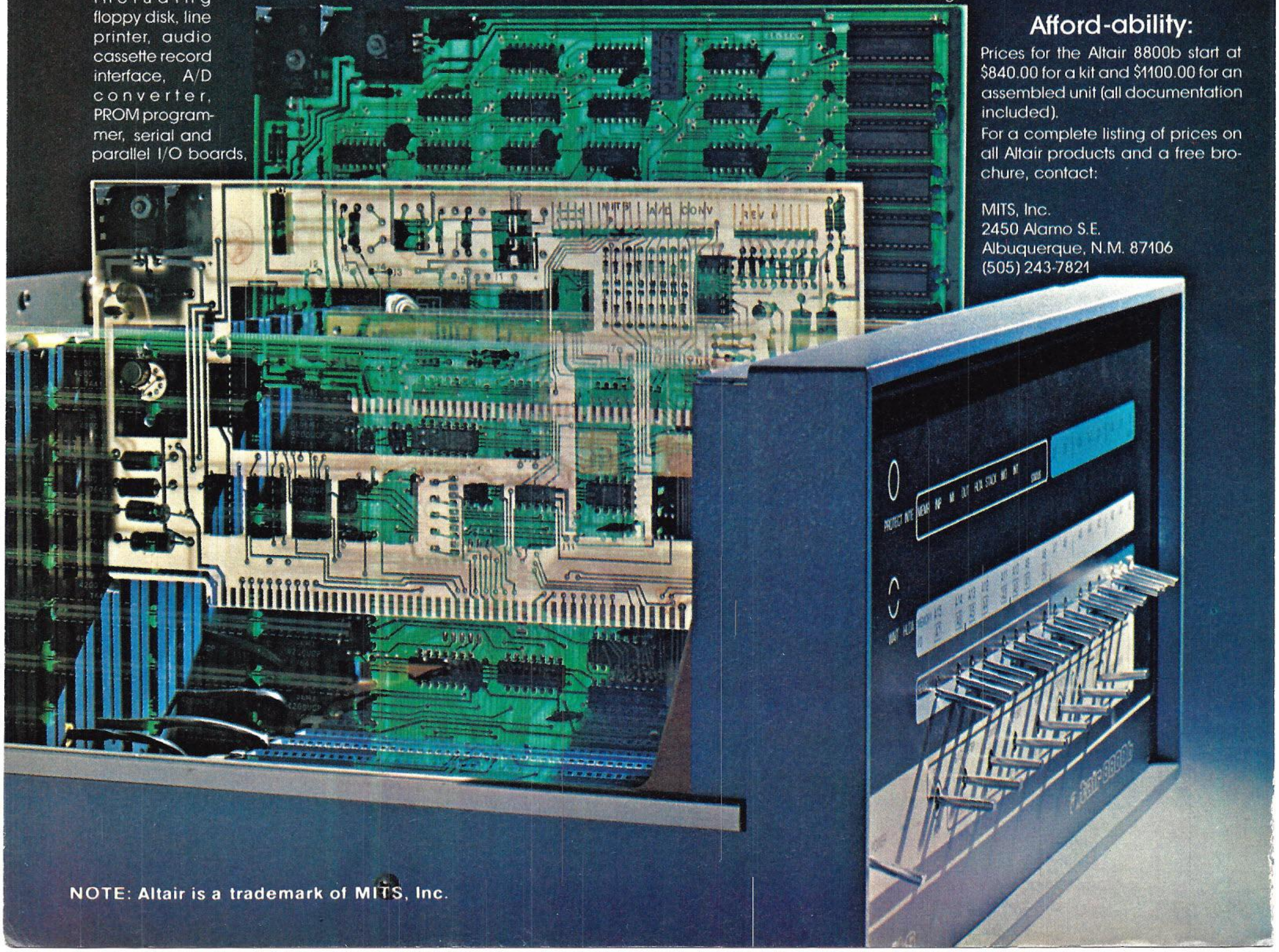

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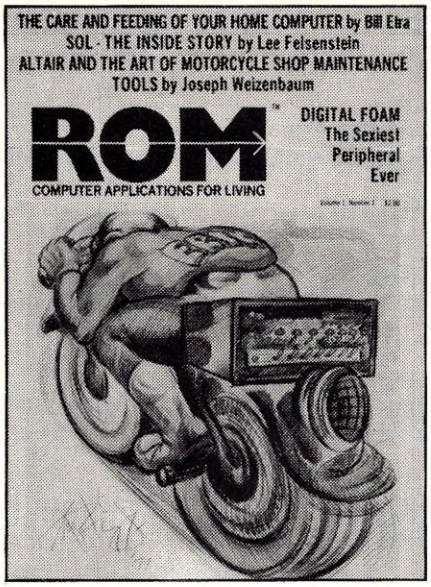
On The Bus



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COMPUTER APPLICATIONS FOR LIVING

This month's cover, an imaginary interaction between computer and motorcycle, is by the well-known artist **Luis Jimenez**. Although primarily known for his fiberglass sculptures, such as *American Dream* and *End of the Trail,* and the monumental *Progress,* fragments which have been exhibited separately, Luis' distinctive style also carries over into pencil drawings. All are suffused with American symbols. He is currently based in the southwest because "the images are here." He has exhibited in the Whitney Museum, the Fogg Museum, and the Fine Arts Museum of Santa Fe, as well as numerous galleries, including the Graham and O.K. Harris in New York.

Sandra Faye Carroll is currently a contributing editor and The Underground Gourmet for *New West* in San Francisco. She has written for such diverse publications as the *New York Times Book Review, City, Earth Times,* and *Oui* on subjects ranging from carcinogens and energy issues to ethnic cuisines.

Bill Etra is an Instructor of Home Computing at the New School for Social Research in New York. He is co-inventor of the Rutt/Etra Video Synthesizer—the first portable voltage control analog video synthesizer, as well as the Videolab. His main interest is videographics, and many of his works have appeared as cover illustrations on various periodicals and books including *Computers in Society* and *Broadcast Management and Engineering*. His current research centers on "The Computer as a Compositional Tool for Video."

Elizabeth Fairchild covered the Computer Faire for *ROM* while helping out at the Processor Technology booth. Since graduation from Antioch College she has worked in electronics retailing, only recently coming into the computer end of the business. She wrote for the college paper while majoring in English, but her piece for *ROM* on the Computer Faire is her first published work since college days.

Peter Feilbogen attended the Rutgers School of Business Administration and Brooklyn Law School. In addition to being an attorney, he is also a Certified Public Accountant. He has been a sole practioner on Long Island for approximately ten years, and treasurer of Data Information Services, Inc. An avid tennis player, he is currently trying to improve his game with the aid of a computer.

Lee Felsenstein was born in Philadelphia and grew up wanting to be an inventor. Outside of that, he bears no resemblance to W.C. Fields whatsoever. Instrumental in establishing the first experimental public-access information-exchange system in 1972, he is presently engaged in further development in that area of communications. In his spare time he has designed the Pennywhistle 103 modem, the VDM-1 video display module, the Sol terminal/computer, and the VID-80 video display card. Lee was also instrumental in forming the original Homebrew Computer Club and currently serves as its "toastmaster."

Ed Hershberger is a New York-based film-maker and friend of technology, ecological balance, high-fidelity, and good soldering technique. He can be found working on movies, breadboarding circuits, or perusing Canal Street for servos, transformers, and sockets for his various projects. Currently, he is working on a portable, zero-voltage switching clock to turn battery-belts on in various motel rooms.

Avery Johnson, with a doctorate in electrical engineering from MIT and five years of post-graduate study in neurophysiology, is uniquely qualified to aid in the goal of making "man-relevant engineering a viable way of living and working." His work is with mobility and sensory aids for the blind, communications systems for crippled children, and physiology of communication. He is currently pursuing research in "soft control material" to provide new interfacing technology between man and machine.

Richard W. Langer is a free lance writer whose articles have appeared in such diverse magazines as *New York, Family Circle, House and Garden,* and *Esquire.* Currently he is a columnist with the *New York Times* and at work on his fifth book.

When **Gordon Morrison** was in the ninth grade, he began designing computer circuits that didn't work. After graduating from the University of Massachusetts, he began work as an engineer for Pratt & Whitney. He left to start his own business—*The Complete Rider,* a motorcycle parts and repair shop in Newington, Connecticut.

Theodor Nelson is the author of the classic *Computer Lib/Dream Machines,* a Whole Earth style catalogue of computer machinations. Presently at the Department of Mathematics of Swarthmore College where he is working on the Hypertext Project, Ted specializes in highly interactive systems for graphics and text. His past experience includes a stint at Dr. Lilly's Dolphin Laboratory and work as a consultant for Bell Lab's ABM system.

Robert Osband took apart his first telephone at age twelve, and hasn't stopped playing with them since. As a Communications Center Specialist for the U.S. Army in Germany, he expanded his knowledge of information transmission and his scope now ranges from the Voice Telephone Network through the Inter-University ARPANET, to the International Telex Network.

Andrew Singer has been hooked on computers since he first built one in 1958. A hard/software consultant, he is fluent in thirty computer languages and knows more than enough about twenty species of machine. His work has included the first medical information retrieval system based on ordinary clinical records, and a large and intricate system for interactive selection of data from public opinion polls. He believes that most software is poorly designed and unspeakably rude, and his Ph.D. research is aimed at improving the architecture and human engineering of interactive systems.

Thorn Veblen is a free lance economist specializing in human value analysis in bionics. He claims to have no upper-class pretensions except for a preference for playing croquet on putting-green-smooth lawns.

Joseph Weizenbaum is Professor of Computer Science at the Massachusetts Institute of Technology. He is best known to his colleagues as the composer of SLIP, a list-processing computer language, and for ELIZA, a natural-language processing system. More recently, he has directed his attention to the impact of science and technology—and of the computer in particular—on society.

Hesh Wiener is the editor of *Computer Decisions,* the most widely read computer trade publication in the United States. Previously he was on the academic staff of the University of California at Berkeley, where he headed the Computer Education Project at the Lawrence Hall of Science. During that time he spent a year teaching blind children to use computers. He designed and built some of the equipment used by the blind students. ▼

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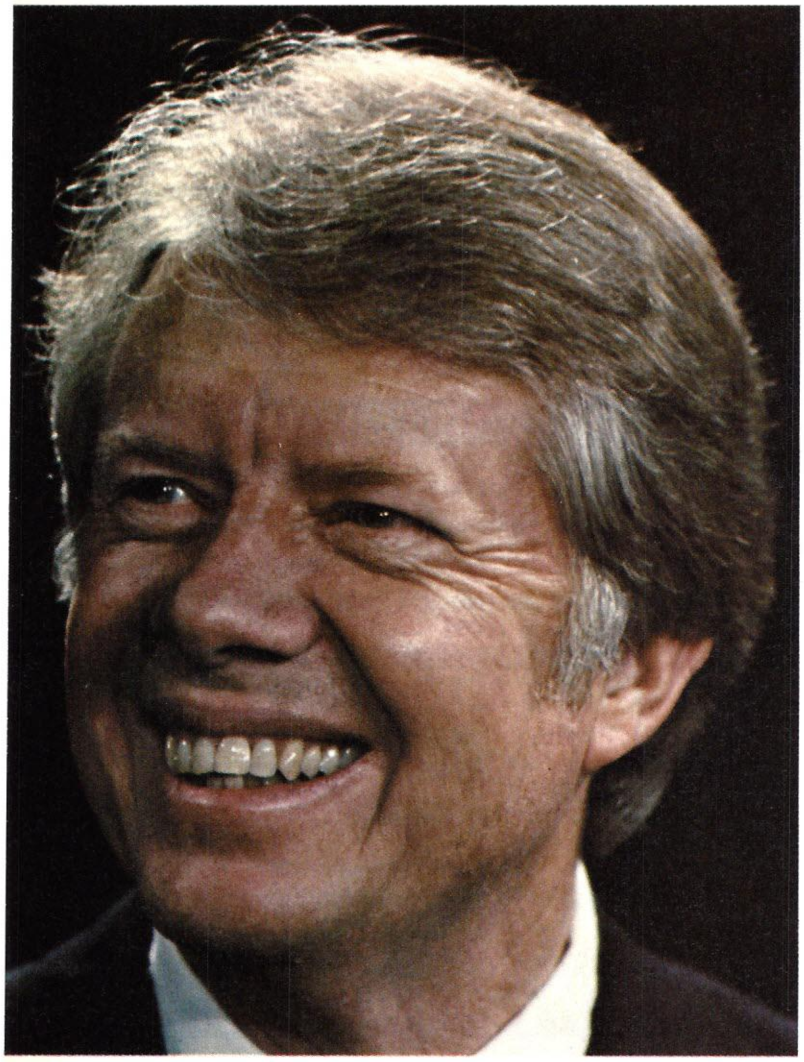

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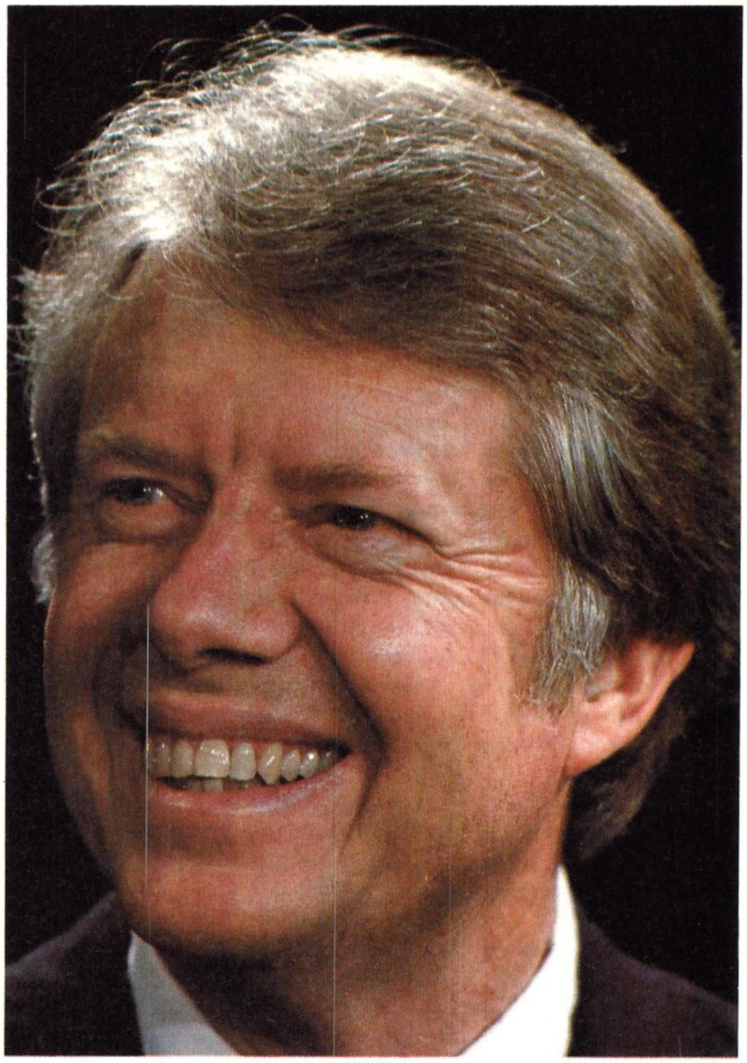

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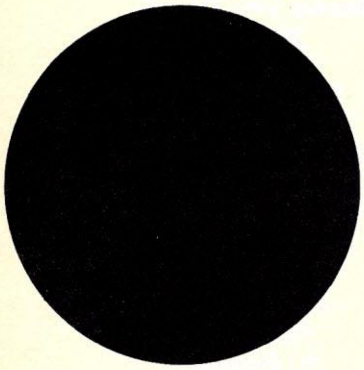
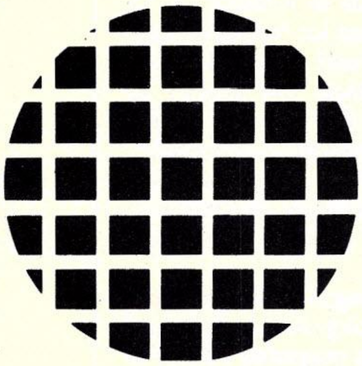


OLD DOT



NEW DOT

TECHNICAL NOTES

Collier's HCM Chromograph DC300 Laser employs an argon laser light source for the high-speed "recording" required.

The laser's six-section scanning beam is created by splitting mirrors responding to digitally-modulated signals coming from the screen computer. In the process, six separate light information bits are exposed side by side on film. Since two information bits are available per half-dot on each revolution, one electronic screen dot may contain four picture-information bits. The new method makes it possible to "interrupt" within a single screen dot (in case of a quick change from black to white in the total dot area) to produce a monitored second half-dot, or even omit it altogether. The result is sharper resolution than ever possible before, when only conventional dots were available. Laser produces a unique dot unlike the conventional square, round or elipitical shape, providing what might be described as electronically-controlled visual "resonance" between finished color proof and original art.

Transparent art is preferred; however, reflection art separates equally as well if it is flexible since it must be fastened to a revolving mandrel for the scanning process.

This Collier system will standardize color correction, undercolor removal, picture and text combinations, picture plus picture combinations and drop-out masking, as well as automatic cropping.

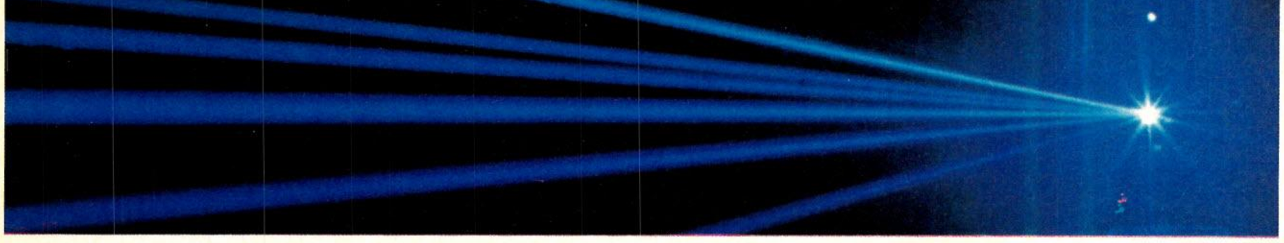
The laser does it.

Here's how it works.

Technically, the laser beam used to control film exposure (and thus "Program" the engraving) is split into six sectional beams. Each of these is digitally modulated by computer to transfer half-dots of picture information per scanner revolution. Since two picture-information "bits" are available per dot in circumferential direction, it's possible to expose a smaller area in the second "orbit"—or even completely omit it (thus producing an actual half-dot or even an elliptical mini-dot).

If that sounds like gobbledygook, don't worry about it. The important thing is, it's here and it works and it gives you image resolution you never could get before.

We'll be happy to demonstrate it for you. Even happier to produce your next set of four-color engravings. Isn't it time to put your graphics on the laser beam? Its address: Collier Graphic Services, 240 West 40th Street, New York, N.Y. 10018 (212) 695-0400.



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Reader Interrupt

Letter from the Publisher:

Home computers invaded my thinking on a sunny day in the Indian Summer of last year. Sugar maples were stirring color into the cerulean sky; my old friend Richard Langer and I were sitting down by the alders on the south edge of Cranberry Pond, idly trying to keep the pickerel from pouncing on lures intended for bass; and Richard brought up the subject of computers. Being to a degree a neo-Luddite, I promptly dozed off, my somnolence aided in no small part by a couple of cold beers and some savory sliced goose sandwiches Richard had brought along for sustenance. I woke up to the sound of an earnest "You can and *must* understand computers now."

That night I plunged into Theodor Nelson's classic *Computer Lib*—not to surface again until I had made my way, bleary-eyed from the tiny print, through *Dream Machines* on the flip side. I wasn't sure exactly what I had learned. I'm still not. Of the fact that my curiosity had been aroused, however, there was no doubt. I set off, if not to conquer the world of binary electronics, then at least to forage along the edges of this vast and unfamiliar domain.

The problem I encountered at the very start was getting across the border. Computerland seemed to be walled in completely by gibberish. Oh, I know it wasn't really gibberish, it all meant something. But even those who tried to explain the jargon to me used the same language to describe terms as the terms themselves did. Apparently I had to look elsewhere for my passport.

There were a number of computer-conscious periodicals at the local computer store. I perused them all: *Byte, Interface Age, Creative Computing, dr. dobb's*. . . . I gleaned a little information from each, but none of them addressed the questions I had as a beginner. There were games to play, and instructions for building computers from scratch. But while I have nothing against exercising my mind and fingers playing *Star Trek,* somehow, it seemed to me, there ought to be more to the future of something as monumental as the computer. After all, it is one of the few tools which could be called extensions of man's mind rather than man's muscles. It is certainly the closest thing to an all-purpose machine ever devised.

I mentioned this to Richard on 13 December. We were ice fishing on that particular day, and Richard, busy pulling in a pickerel (we weren't so fussy about our fish in that winter weather), suggested innocently, "You're in publishing, why don't you start your own magazine, one that you can understand?" I took the bait, and here is *ROM*.

Apart from being *ROM*'s first catch, my role in the magazine is minor. I had a notion for a magazine I'd like to read. If we ask the real *ROM* to stand up, we see it's the writers, artists, and staff that are making it all possible. A more dedicated, hard-working, and talented crew would be hard to find, and without them I'd still be out there casting for bass.

I also owe a big thank you to many others not listed among our immediate helpers. Milton Glaser took one look at my original logo, crumpled it up with the simple comment "You can't do that"—and contributed our ROM-cum-arrow. Readers-to-be who, like myself, were beginning learners in computer lingo, influenced the placing of the ROMtutorial—the running dictionary of terms you'll find right alongside our articles in case you need some help on the terminology. Friends and strangers too many to mention by name have encouraged me at every step along the way. They and we have changed *ROM* already, between the time of its conception and the closing of its first issue. And if there are some things we would like to have done better in this issue—a little extra polish here and there—well, *ROM* wasn't built in a day.

And with that thought we pass the fishing lines to you, our readers. We're not printing those traditional letters about how great the magazine is in the first issue—after all, at the time Volume I, Number 1 goes to press, who's had a chance to see the magazine besides Aunt Tillie? Our writers are writing to you. Let's not let this magazine become a one-way medium, unresponsive to feedback as so much modern communication is. Let's have those letters—we're listening. ▼

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A Note to Contributors:
ROM is always looking for good computer applications articles from people with up-and-running systems. We also will be glad to consider for possible publication manuscripts, drawings, and photographs on other computer-related subjects. Manuscripts should be typewritten double-spaced, and a stamped self-addressed envelope of the appropriate size should accompany each unsolicited submission. Although we cannot assume responsibility for loss or damage, all material will be treated with care while in our hands. Contributions should be sent to ROM Publications Corp., Rte. 97, Hampton, CT 06247.

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Missionary Position

by Ted Nelson

The myth is everywhere.

We see it in the computer systems that laymen collide with as victims: as students, as welfare clients, as hospital patients. We see it in the computer systems that people collide with as consumers: charge accounts, billing systems, credit-denial systems, account-shutdown procedures. We see it in the computer systems that employees have to learn to use without understanding.

Computer programmers have been fooled by it, and have in turn fooled others. Computer salesmen have been fooled by it, and have in turn fooled others. Computer manufacturers have been fooled by it, and have in turn fooled others. Laymen have been fooled by it, and have no way to turn. So they hate computers.

The myth, most simply expressed, is:

Computers are oppressive,
and this is good.

You have to have a number. Things have to go in on cards. "We can't find that out, it's on the computer." The computer "made a mistake." Too bad for you. "It can't be changed, it's on the computer." "Sorry, your name can't be over twelve letters." "You couldn't understand that, it's computer code." "It has to be set up exactly this way for the machine. Those are the only categories." You can't understand it, it's the computer's fault, it has to be that way, there is no recourse.

The myth is: Computers are oppressive, and this is good.

Progress means regimentation. Complication is good. To use computers means everything has to be changed into numbers. When you computerize a company, its systems of work have to be completely thrown out. A man in an expensive suit who uses baffling phrases must know a lot. There is only one computer manufacturer. Nobody could sell a lot of computers unless they were the best possible. If a computer product is complex and incomprehensible, it represents the latest and the best. If a thing is "very technical," it must be right. Computer people always know what they're doing. And progress has to hurt.

It's all one big damned lie.

Intimidation, mystification, regimentation—the everyday kit with which all too many computer people, and some computer companies, have gotten their way: the litany, the "God's Will," of the computer priesthood.

But every computer system was set up by somebody. All those restrictions and nuisances, however excused, come from the conscious choices made by people, somewhere along the line.

(I remember vividly a meeting with the guy who was nominally in charge of security for a big-computer installation. A colleague and I wanted to attach a graphic system to the big computer, because we didn't understand the game. I will never forget the malevolent grin with which this fellow refused our every request. He had an answer to everything, neatly couched in systems terminology, but the grin and the meaning were entirely clear: you *will* not attach a graphic system to my computer. The game was to prevent the growth of interactive, potenially independent systems. And prevent it he and the rest of them did.)

And now all this is changing.

Little computers, with easy-to-use programs, are cropping up all over. And many of the people working on these systems have a real commitment to the opposite idea: computers should be easy to understand and easy to use.

The impact of these developments on the business world is going to be formidable, profound, and revolutionary. Easy systems for accounting, typing, filing, scheduling, and personal data basing are appearing quickly. First to grab are the innovative small businesses, but larger firms are following this lead.

And a paradoxical situation is emerging. Those companies with big computers, big computer staffs, complicated procedures, and everything nailed down are looking on in horror as their competitors—the competitors who earlier lagged in catching up with "progress"—begin to run circles around them. For the age of "one person, one computer" is almost here—the age of one-by-one transactions by people who know what they're doing.

The structure of the computer world evolved not from real considerations but from marketing tricks. Big computers and batch processing, once necessary, became a way of locking out minicomputer manufacturers and interactive systems. But it will become plain for all to see: most usage of computers is best done on interactive minis and should have been all along. Large data bases need large *disks*, not large computers. Interactive input and query systems can eliminate forms, eliminate paperwork, cut down on the red tape we all hate. Small computers for typing can not only make typing accurate and virtually instantaneous, they can automatically file in multiple directions simultaneously, so that, for example, a letter automatically connects with all the files on which it bears. Interactive systems mean that people can understand what they are doing rather than being brutalized into dead-end clerical peonage.

Presently, armies of programmers are still employed doing complicated things that someone thinks are wanted. But when the smoke clears, a great deal of this is going to turn out to

The impact of these developments on the business world is going to be formidable, profound, and revolutionary.

have been make-work: ad hoc, ungeneralized, and unstructured programming elaborately interfaced to horrid operating systems. The general problem is not *more* programs but *better* programs. Particular and temporary programs are going to be replaced by general and simple ones. I believe that in the future we will find a few simple programs doing most of what's wanted in business. And a new generation of businessmen will see that computers can be easy and accessible.

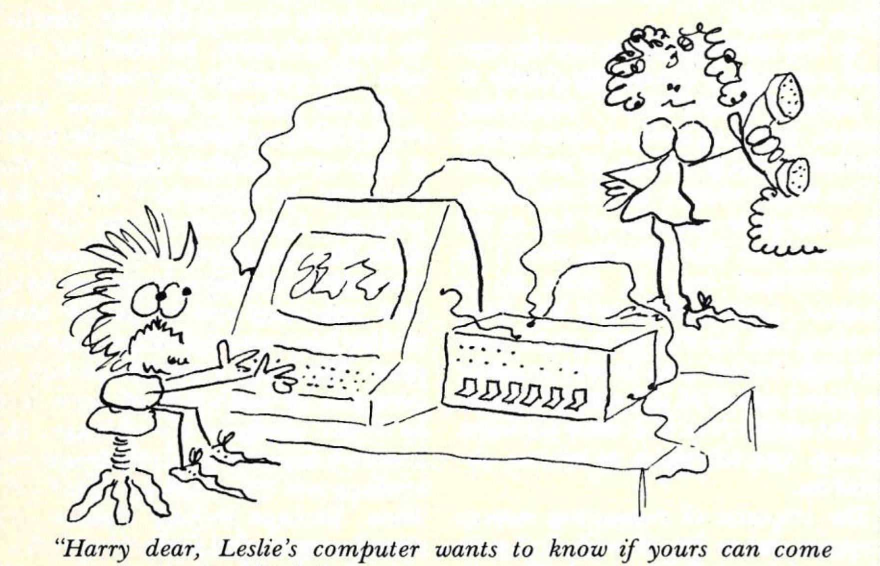
Reliability will increase: instead of the system being down, individual *units* will go down; a guy will just borrow a computer from the next desk.

We are on the brink of the home-computer age. By 1980 there will be personal computers, I believe, in some ten million American homes.

A host of services for the hobby and home user will appear, evolving from the computer store. Right now, a computer store is a place where you go to buy a computer kit; you're lucky if there's an assembled unit in stock. Tomorrow, the computer store will be an expanded service emporium as well, where you pick up your printout (like film from the corner drugstore, except you tweedled it in over the phone), where you take lessons, rent terminals, copy program cassettes, time-share, say hello to your friends. The terminal cluster at tomorrow's computer store may be like the potbellied stove in the general store of a generation ago—a place where you swap gossip and whittle, even if the whittling is done on a data structure rather than a physical piece of wood. When they get their act together, many of these stores will expand in franchised chains like McDonald's and 7-11.

What is not generally recognized yet is that there will be considerable overlap between home and business computer systems: my estimate is that they will have about 70 percent of their programs in common. All comers need text handling, retrieval, scheduling, financial planning, bookkeeping. Home users, however, do not need order processing and inventory; businesses do not need games.

The new developments in computer usage will cause convulsive changes, not merely among users, but within the computer community itself.



"Harry dear, Leslie's computer wants to know if yours can come out and play Star Trek."

Korkie

Now the programming community contain many Good Germans—doing what they're told and not wondering about it—as well as a few Nazis, who enjoy oppression and know full well what they are doing. But as people at large begin to find out how basically simple computers are, how easy and how incredibly useful in everyday life, it's not necessarily handshakes all around. I think it likely that there will be a lot of anger and a lot of hard questions asked. And the people who made computers oppressive, as well as artifically and intentionally complicated, have a lot of explaining to do.

This may lead to a period of agonizing reappraisal and collective guilt not unlike what followed World War II, when the Good Germans had to walk through concentration camps and confront what they had been contributing to. Some computer people themselves will come to feel that they have been living a fraud. Combine this with sudden unemployment across the field as fewer programmers are needed, and we are going to see suicides, weird religious movements, and perhaps strange political developments among the mortified castoffs.

The good goals are still attainable. On our way to a happier world, a better world, a more knowing world through computers, certain unfortunate circumstances have arisen. We can find our way out of them. There will be painful dislocations, but we can get there—to a world where the messy crud is taken care of automatically and information comes to us where, when, and how we want it. A world with a lot more knowledge spread around in it—and a lot more fun.

And it may be that access to information, *real* access under people's total control, may yet make this a better world—may reverse the tides of apathy and illiteracy that rise daily.

Great changes are in store.

A spade is a spade.

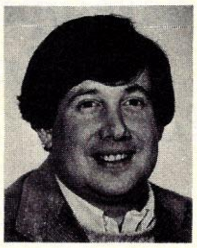
The emperor has no clothes.

The true frontier is not technical complication. It is simplicity and clarity.

The human oppression and degradation of the first computer era are coming to an end. The new age of computing will not build on the past, but repudiate it. We—peoplekind—could have used the last ten years. But let us see what we can do in the time that remains. ▼

The Human Factor

by Andrew Singer



"CHGAT, NFA...VFC DB ASMB?"

"RCTRLO, CSISPC, MNTR!"

Two CIA agents talking about the White House tapes? Eisenhower's message to Patton? An Albanian proposition? No. It's a sampling of computer language keywords.

Haven't you ever needed to RCTRLO, or perhaps CHGAT? certainly you often use NFA or TX in an NCS or NLN sequence. . . . What? You don't know what an NCS sequence is? Well, truthfully, neither do I. It's only one of a "vast array of options" allowed in only one of the many statements of an interactive computer language billed as "concise" and "natural." Since "only a subset of the possible variations" of the statement would fit in the main reference manual, and since I don't have the supplementary manual that would define it, I can't tell you precisely what an NCS sequence is. Perhaps it's better that way. The actual definition of an NCS sequence might be more confusing and obscure than the code itself.

Only three diferent languages are represented in the keyword examples I have given, but they typify the current conditions besetting people who have to work with computers. You don't believe me? Well, NCS came from somewhere; see Box for the culprit.

In case you think I pulled an extreme example out of my hat to prove a point, think about this: in a recent study by DATAPRO, a national company that evaluates computer products by surveying users, the Xerox CP-V system from which "the culprit" is drawn was rated by users as the best of its class. It is also one of the languages least widely used. In a given day probably no more than fifty thousand people struggle with it—a mere handful compared to the millions sinking in some of the systems rated as poorer.

Of course, if you have just tuned in to the computer revolution, you may be asking, "Exactly what are these computer languages, and why are they used at all?" The answer is simple. Computers only do what they are told. You tell them to carry out your instructions, using one of several hundred languages. Each of these languages is unique. Each has its own grammar, spelling, and punctuation rules, which are concocted by the designers of the computer system.

Once you begin to work with a computer, you are no longer a person, in the eyes of the computer industry. You become, by definition, a user. Being a user is not easy, since you are completely at the mercy of the system's designer. And the quality of that mercy is often strained.

The Culprit

```
C[OPY] d[(s)][/fid[(s)][,fid[(s)]]. . .][;d[(s)] ──┐
┌──────────────────────────────────────────────────┘
└─ [/fid[(s)]][, fid[(s)]]. . .] . . . ⎡TO
                                       ⎣OVER ─┐
┌─────────────────────────────────────────────┘
└─ d[(s)][/fid[(s)]]]
```

(From the Xerox CP-V Time-Sharing User's Guide)

Copies file between devices or between RAD storage and devices:

Options:

d may be CP, DC, DP, FT, LP, LT, or ME.

s may be a data code (E, H); a data format (X, C); a mode (BCD, BIN, 7T, 9T, PK, UPK, SSP, DSP, VFC, NC, FA, NFA, TX, DEOD, K); a sequence (CS, NCS, LN, NLN); an account (RD, WR); or selection (x-y).

At five in the morning one day several years ago, I was staring glassily at a terminal in the M.I.T. computing center, trying to find an error deeply buried in a large system of programs. (You might wonder why I was sitting at a computer terminal at five in the morning, but that's another story.) At the terminal next to mine sat a student, another user. We had been working side by side since about nine the night before, and he was certainly as glazed and tired as I was. He stared at the terminal as if it were his worst enemy, and he began to mutter obscenities.

The etiquette of computing centers requires one to ignore such outbursts in particular and one's co-workers in general. However, when the student gave the terminal a hard kick, ripped his listing out of the machine, and stomped from the room, my curiosity got the better of me. I retrieved his listing from the recycling bin, uncrumpled it, and looked it over. From his sign-on identification, I could tell that he was a student in an introductory computing course, working on a beginner's problem.

It had taken him quite a while to figure out how to type his program into the computer. From the listing it was apparent that he had completely retyped the fifty-line program three or four times before discovering how to correct a single line without redoing the whole thing. At last he had typed in the entire program successfully, but that was only the beginning.

Next he had to get the program to run correctly. On his first try, he got an error message from the computer. Twenty tries later, he was still getting the same error message. Since it arrived in code, I doubt that he even knew it was an error message. Finally, by trial and error, he fixed the mistake. The program ran correctly.

At this point he must have been feeling fairly confident. Then he made a fatal error. Before signing off the computer, he requested it to save his program. Unfortunately, he did not make his request correctly. There are times when making a computer hang onto something can be harder than making it accept something in the first place. The computer informed him in code that he had made an error, but he didn't recognize the message. He probably assumed the code meant everything was OK. And he signed off. Then, perhaps sensing disaster, he signed on again just to double-check—to make sure the program was still there. Of course it wasn't.

Given the circumstances, I think that particular student showed considerable restraint. I have seen students confronted with similar situations do much more damage than he to the terminal at whose keys they suffered. The phenomenon is in fact so widespread in university computing centers that there is even a term reserved for it. It's called "trashing" a terminal. Trashing is a major cause of terminal malfunction, and it creates a vicious cycle of aggravation for other users.

But wait, the story isn't over. The following day I was passing the consultants room (all large university computing centers have a staff of consultants to help users solve problems), and I saw the student haranguing the consultant about how the computer had lost his program. The frustration level in computing centers being what it is, consultants must listen to a lot of irate users, and they learn rather quickly that most errors blamed on the computer are the fault of the naive user, so they sometimes lack sympathy. (Very little research has been done on the subject of user/consultant relations, but the area is ripe for investigation.) In short order this particular consultant pointed out to the student what the error had been.

To which the student objected, "But I lost my whole program!"

To which the consultant replied, "That's your problem. I guess you won't make that mistake again."

Those last two sentences neatly sum up the state of affairs for today's computer users. If something is difficult to use or costs you extra time and effort, it's "your problem." If you slip and destroy ten minutes'—or ten weeks'—work inadvertently, you "won't make that mistake again." Indeed, after a first unpleasant brush with using a computer, many people decide that the computer itself is too much of a "problem" and that in the future they "won't make that mistake again."

Computers were originally created to be tools for people. But the people who build the tools seem now to have forgotten that original premise. In *Erewhon*, Samuel Butler wrote:

> So that even now the machines will only serve on conditions of being served, and that too upon their own terms; the moment their terms are not complied with, they jib, and either smash both themselves and all whom they can reach, or turn churlish and refuse to work at all. How many men at this hour are living in a state of bondage to the machines?

This prophetic paragraph, written over a hundred years ago, accurately describes the state of the computer field today. If it is not to be equally accurate in another hundred years, we must do things differently.

The explosion of popular interest in computers offers a great opportunity to return the machines to people. Unfortunately, there are some indications that computer systems for hobbyists are headed in the same old direction. Three of the keywords that began this column—CHGAT, ASMB, AND MNTR—come from one of the newest hobby systems, the **ICOM FDOS-II.**

It is time to put an end to this nonsense.

From this column we will be conducting a technology watch. We are particularly interested in hearing of your experiences—pleasant and unpleasant—with computers large and small. We will try to cite, as a regular feature, a "Disaster of the Month." Nominees for the Disaster Award are welcome from any source. Periodically, we will review computer systems or projects in a critical fashion, and we will not be afraid to make waves where necessary. Whenever possible, we will interview the designers of the systems to which people are being subjected. Our primary goal will be to stimulate greater awareness of and concern for the human factor in the computer field. Technocrats beware!

Few would dispute that we are at a turning point with respect to computers. The low cost of computer hardware, the influx of hobbyists, even the programmable microwave oven—all signal change. I believe that the breadth of access to computers afforded by this change will force a much greater concern for the people who must use them.

We have had twenty years of "That's your problem." Let's not make that mistake again. ▼

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Legal ROMifications

Can your personal computer get you into legal trouble—can you protect yourself from software and hardware bootleggers?

by Peter Feilbogen, attorney at law

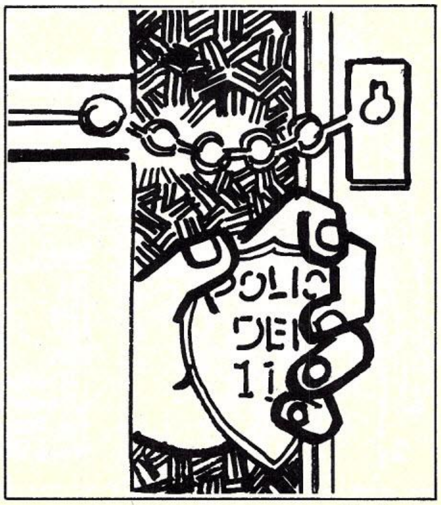
Do you sometimes worry about the legal implications of the way you and your computer work together? Can "it" get you into legal trouble with a faulty program, a bug you didn't catch? What if you copy other people's programs? Or change them? How do you patent your brilliant new idea? What are the legalities of computer telephone communication? Or for that matter, what are the implications of wireless data transmission? If you have a small business system and you use an outside service bureau, who really owns the data, and how do you protect yourself?

These are just some of the questions which may send you scurrying out to a lawyer. But then you may have a bigger question—how do you find the right lawyer? (Usually referred to as an *attorney* in the trade.) Not every attorney is right for every client. There are several factors to consider.

Attorneys come from varied backgrounds. A law school only requires a baccalaurate degree; no specific major is required. Thus, your attorney may have an undergraduate degree in philosophy, accounting, history, or even engineering. Advanced degrees in law are not common among practicing attorneys. Usually only those involved with academic pursuits obtain such degrees. The degree "Juris Doctor" is equivalent to the Bachelor of Laws degree formerly awarded.

In New York, as in most states, there are only two recognized specialties: patent law and admiralty law. Other categories of the law such as tax, real estate, or matrimonial law are beginning to gain acceptance as specialties, and in the future, attorneys may be certified as specialists in these fields. Some day there may even be a specialty in the questions personal computer users ask, but that's some time off.

How can you determine if your attorney can meet your needs? The easiest, best way is to speak to him and ask him. You should not expect a sole practitioner or small law firm to be an expert in every phase of the law. However, your attorney should be experienced in the areas that concern you most heavily. A general practitioner can usually handle most family needs such as the purchase and sale of a home or business or drawing a will. And he may have more problems helping you fight the department store's computer that has run amok and claims you purchased $100,000 worth of pajamas.



Rex Ruden

Today professional fees are being questioned and examined. While most people are willing to pay a fair fee, they do not want to overpay. An attorney's expenses include, to mention only some of his overhead, an office, a secretary, and a library. The attorney's skill and experience must also be considered when making your decision about a legal relationship. Has he worked at the level of the court which may be involved in your case? (A local court? The United States Supreme Court?) An attorney who bills a client approximately $50.00 per hour is quite fair. You might, however, request a flat fee for your particular matter. A specialist or a large firm may charge substantially more.

To make attorneys more accessible to the public, certain types of cases can be handled on a "contingent fee" basis, so that the attorney's fee is a percentage of a monetary recovery. The most prevalent and widely known field which uses this method of remuneration is personal injury. But it is also used in other fields such as land condemnation and collection matters.

Once you have found an attorney, and especially if you feel you are paying an exorbitant fee, you may want to know what you will be getting for the price of this magazine.

I will be discussing in this column how you as a computer buff may be running into legal problems. They can come from many directions. After all, you didn't always write your own programs, you use the mails, and someone out there keeps eyeing the telephone line. Or perhaps you have thought of new products, improvements to existing products, or different methods or designs. Any one of these activities might have gotten you into a legal hassle, or, if it hasn't happened yet, it may be avoided (or helped) by some preliminary advice. Hang in there by your boot straps and write me c/o ROM when you've got problems. ▼

Telegrasping at Midnight 'Neath the Starry Sky

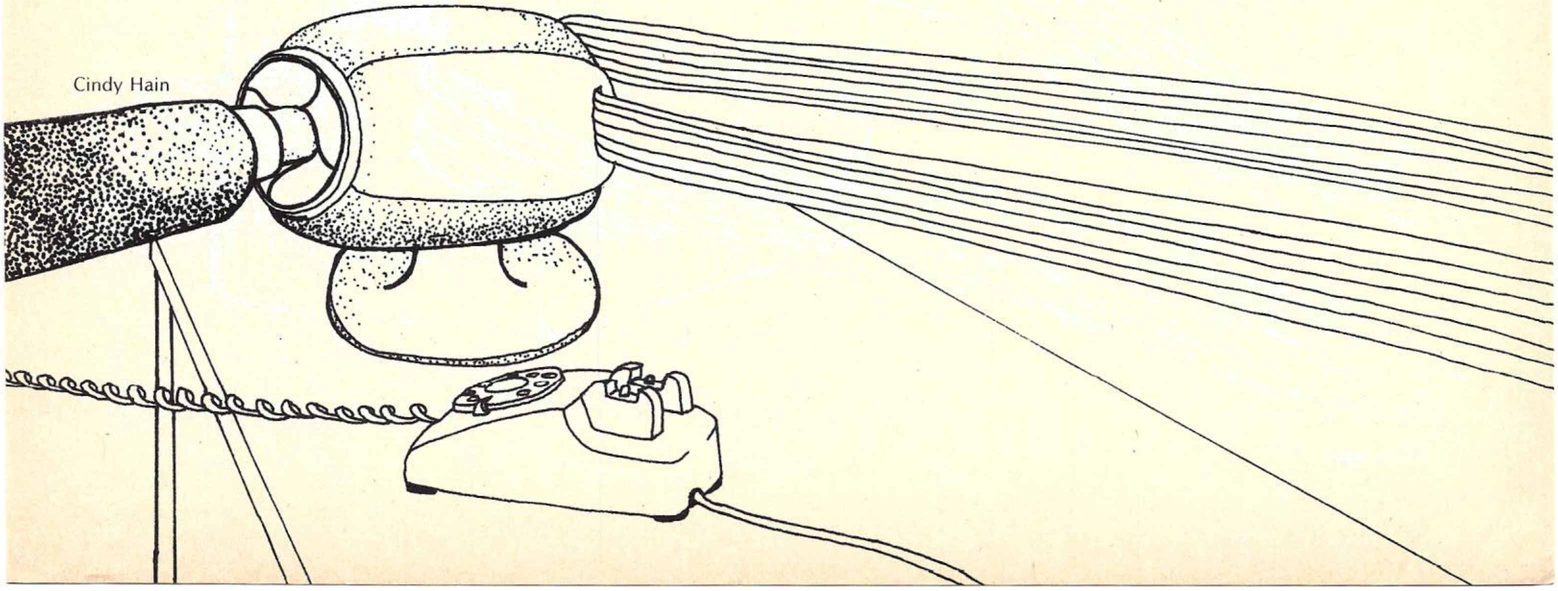
by Avery R. Johnson

Think of it. An age-old dream as recurrent as the hunger for unaided flight, a communication scheme so rich in its complexity that one could actually make love to someone else at great distances of space (or maybe even time? Casanova, Marilyn Monroe, the Tantric Sages?). Dream on, friend, it's not in the cards, although occasionally our technological hubris has led us to think it all might be waiting right around the corner.

Shepherd Mead of *How to Succeed in Business*... fame wrote a hilarious satire in the '50s called *The Big Ball of Wax* in which love and religions were marketed vicariously with a helmet communicator. Many other sci-fi authors have proposed their variations. And then in 1969 a hoax called "Intersex" was announced in the September issue of *Architectural Design* as a news item that would have done credit to Orson Welles—but again, no substance to it.

Now, I don't want to spoil anyone's fun in speculating on these matters, but the problem boils down fundamentally to the impossibility of separating out what is input from what is output in the richness of intimate dialogue. Science and technology have thrived so grandly in all those places where observer and observed could be distinguished that it's both a shame and a relief to be able to wag a finger and say, "Sorry, gottcha this time!" Touch and movement—the haptic reflex loop—are such that that which touches also moves and is itself touched, and there is nowhere between lovers that you can pass your mathematical plane and say, "Here, see? This message is going this way and that one the other way." No way. No surrogate simulation can reproduce all the wonderments of intimacy, no matter how many sensors and transducers you care to incorporate at the interface: the information shared by two real people is just not of that nature.

Is there a way to share touch and movement at a distance? Consider TELEGRASP. Maybe it's an idea whose time has come.


Cindy Hain

Let us instead put an SOC on board, give it control, give it access to how well it's doing.

You might be able to build a clockwork doll of modern hi-tech to play an exciting game with you—for I'll never discount the ability of an individual to fantasize the rest. That's not what I'm addressing here. What *can* we do that might be worth doing to enrich, let's say, the intimacy of a telephone call? Is there a way to share touch and movement at a distance, a way of providing our remote outreaching with context we normally think of as exclusively the domain of face-to-face presence? Consider TELEGRASP. Maybe it's an idea whose time has come.

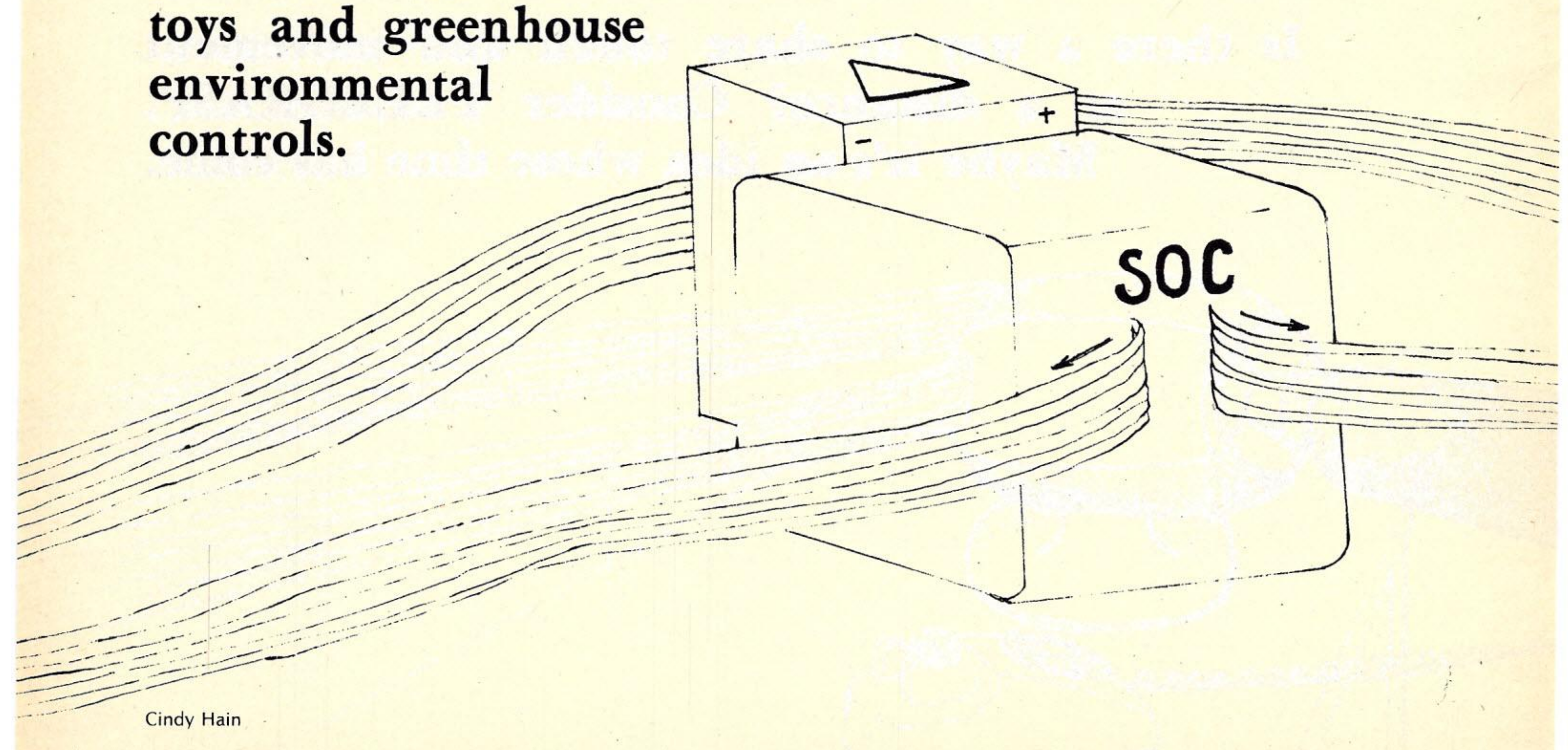
What's really involved in what we call "holding hands"? Is there something special about hands and their modes of grasping that is unique? I don't think so. For the kind of contact I have in mind, an arm around the shoulder, knees touching beneath a table, the nudge of an elbow, or any sort of labile pressure can make a message spoken very differently received by the hearer being touched from what it means for someone else, and that's the point: we're looking for a simple exchange of responsive touching that can make a difference in a dialogue. If we resort to thinking about surrogate hands and the making of measurements upon them as to how they are being touched, or the making of similar measurements on the real hands of the respondents, we will again have lost the game. It turns out to be a lot easier than that.

Imagine that we have provided two *environments* for hands, one at each end of the line. They might look like enclosures the size of a shoebox, with an opening at one end. Say that they each contain about half a dozen inflatable bags that would more than fill the space if all were inflated fully. I insert my hand in one, you yours in the other, and the bags inflate to enclose our hands everywhere with a firm pressure.

Contained with the bags are about an equal number of sensors engaged in making some quantitative measures on one or more bags: some might be circumferential strain gauges, others might sense the extent of contact area between two bags, and another perhaps would monitor the net rate of air flow into and out of all the bags taken as a group. The point to notice is that the system is making its measurements upon itself, not upon your hand or mine. If the two environments have been made reasonably identical in size and placement of bags and of the sensory apparatus, then our hands may be thought of as intrusions into two identical spaces, and the differences in the information retrieved from the respective sensors will give some measure of what our two hands are doing differently.

Let us now suppose that the differences, by respective pairs, are introduced as a set of error signals to a "multiple-goal, multiple-actuator, self-organizing controller." Well, now,

There's an unlimited assortment of potential applications like toys and greenhouse environmental controls.



Cindy Hain

Don't Sit There Analyzing, Pull Up Your SOCs!

As an illustration of contrasting approaches to a control problem—classical "analytical" method versus self-organizing controller (SOC)—consider how one might aim an orbiting reconnaissance satellite. The problem is as follows: At intervals you want to reposition the satellite's axis with respect to the earth's surface, but since the vehicle is to be in orbit for years, you can't afford to send along enough thruster fuel to last. However, solar panels can absorb and store electric energy indefinitely, there is a magnetic field around the earth, and a current passed through a coil can elicit a torque from that field. So your vehicle carries three coils, placed at right angles to one another, through which currents may be passed for aiming the cameras. Now the question that remains is: how much current in which coils and when? Remember also that you want to conserve energy resources (current) whenever possible.

The classical approach directs you to have an on-board device *measure* the strength and direction of the earth's magnetic field in the place where the satellite is now; other sensors are to report on the attitude of the satellite with respect to the limb of the earth. All this information is sent to a computer on the earth's surface, and computation proceeds.

The first step is usually to make an estimate of what the magnetic field around the satellite will be like when the entire computation is completed. That alone is no trivial task—nor can it really be carried out precisely—because of the gross irregularities in the magnetic field in some areas. Next are solved the geometric and energetics equations that will make possible the rotations required, given the available resources, and these are usually worked out one axis of rotation at a time. Then the whole procedure has to be carried out a few more times to refine the positioning further, since the first adjustment is only an approximation. The method is time-consuming and energy-wasteful, and it will not account for changes in the functioning of the satellite's sensors or coil "actuators." Implementation is difficult and fraught with sources of error.

Let us instead put an SOC on board, give it control over sending currents through coils, give it access to how well it is doing relative to its goal, that is, give it the moment-to-moment information about the satellite's orientation relative to the limb of the earth. The command from earth is "Go" and it goes from where it is to where it ought to be—in one apparently continuous movement such as you might make to reach for a pencil on a shelf behind you, without having to command each of the dozens of muscles separately involved in the task. The SOC does not have to know a priori which current direction is "up" for which coil; it finds out very rapidly by performing random experiments in microtime (a very short sampling interval relative to the response interval of the vehicle). In fact, it doesn't have to know that there is a magnetic field out there to interact with, nor what size or direction it might have at the moment. And furthermore (this is for all you armchair physicists who think you really know what is "out there" in space), if there were somehow another field present that currents in coils could push on, the SOC would make immediate and relevant use of it; the measure-compute-decide-command system in the "analytical" example might never know this other field was there and fail hopelessly—needlessly—in its task.

A subgoal, perhaps of lower priority than the accurate and rapid positioning of the satellite, can be the conservation of energy by the entire system, and this subgoal will be cultivated commensurately with its priority. If some part of the system starts to fail, the SOC can "work around it." The performance will be slower, perhaps, or of lower resolution, but the job will still be done as well as possible. The aerospace industry calls this "graceful degradation." Nice. In the classical case, if you don't tell the computer on the ground that something has changed, it will give commands as if everything is up to par—and err accordingly.

The magic of the SOC lies in its ability to perform its job without a priori knowledge of the connectedness of its environment. But the internal organization is astoundingly simple. Random-noise generators, low-resolution means of keeping track of successes in the recent past, and a rich cross-connection of control pathways are the essential ingredients. Nothing precise. Loose and flexible. SOCs will be most useful where natural growth systems are enclosed in artificial containers: Greenhouses, aquariums, (schools?), prostheses. The SOC produces behavior best described as *heed without habit.*

you ask, "What the hell is *that*?" I don't really want to explain fully here what an MG-MA-SOC is, but I'll summarize. Back in the '60s, when some pretty hairy control problems presented themselves to the designers of supersonic aircraft and space satellites, the control-systems people came up with controllers that could do some astounding jobs very well. You could give the controller information about how well it was doing moment-to-moment relative to achieving a handful of goals (the systems people called this "performance assessment"), and at the same time you gave the controller carte blanche to fiddle with every available output to the system (the "actuators"), even though some of its decisions in the short run looked crazy—oh, excuse me, "counter-intuitive" sounds better.

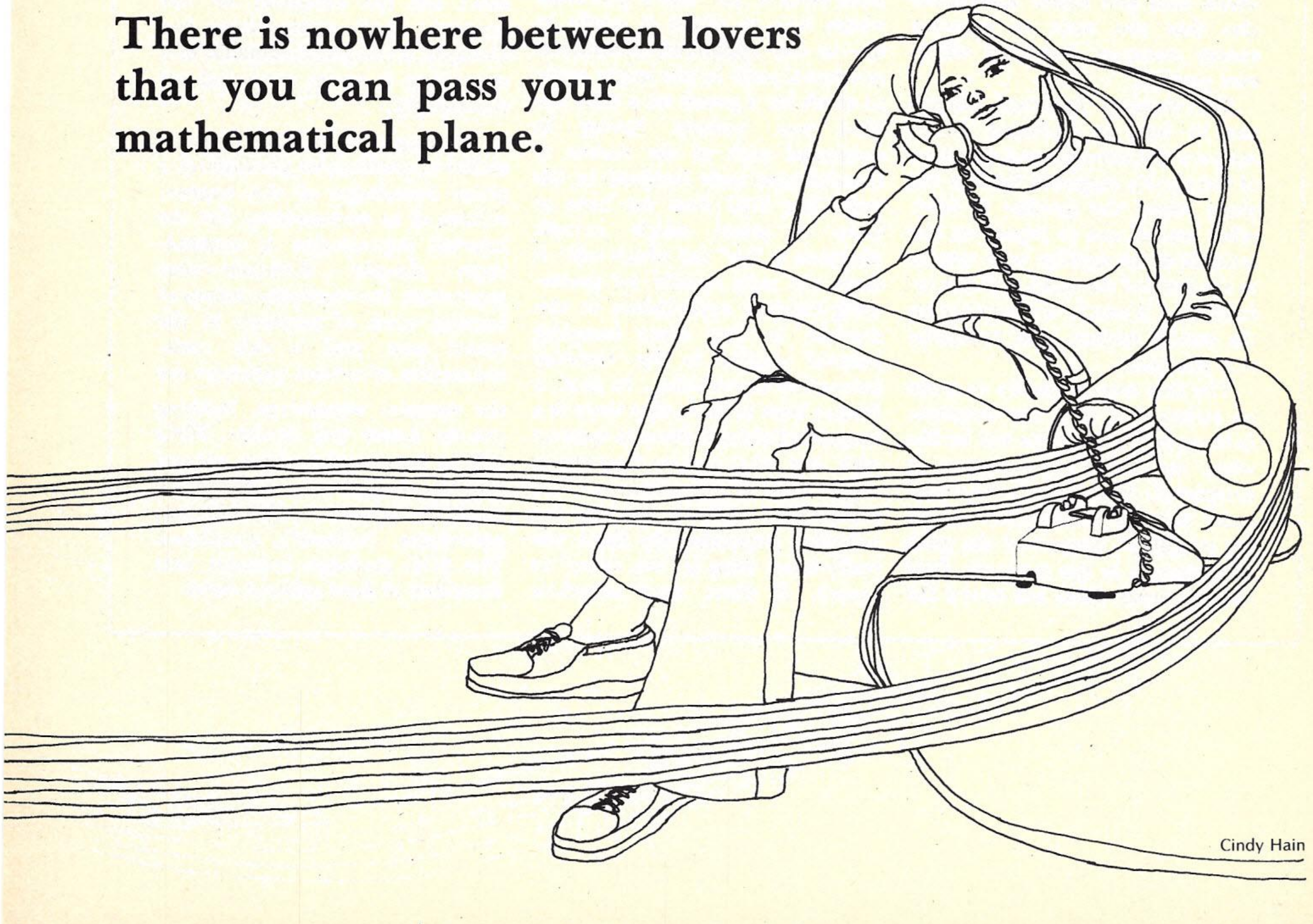
Anyway, these controllers can keep a system on track so well—even in the face of disturbances like variables suddenly reversing the meaning of *up* and *down* or some part of the system failing altogether—that no sophisticated "decision theory" structures can keep up with them. Nowadays the SOCs are controlling things like steel rolling mills, but there's an unlimited assortment of potential applications like toys and greenhouse environmental controls that can use them to good advantage. I think it won't be long before SOC-on-a-chip is with us.

In our case—TELEGRASP—the self-organizing controller will look at the paired measurements from the hand boxes as error signals to be nullified, and it will have control of the air bags to try to accomplish the task. We will make only the simplifying stipulation that the same command, "Inflate" or "Deflate," must go simultaneously to the respective bags at the two ends of the line. What will happen?

Unless the two of us remain terribly flaccid and unresponsive, the system will engage in a constant struggle to bring about a sensed condition of identity between the two ends. The goal is unattainable, relatively speaking, but the struggle will be felt by both of us. The changes in the struggle that result from my movements will be redundant for me and will go essentially unnoticed, but those that result from *your* movements will charge my handbox with something of your presence and, as adjuncts to our conversation, will put us literally more "in touch with" each other's feelings and reactions.

Anybody want to try it? (Try building TELEGRASP, that is.) The realization of the system as a laboratory toy seems simple enough, and as a telephone add-on it doesn't present much of a bandwidth problem. I made a start on it back in 1968, but our laboratory folded and I went on to other things. To my knowledge, the name TELEGRASP has never been copyrighted, nor has an embodiment of the system been patented. I'd enjoy seeing the gadget emerge some day. ▼

There is nowhere between lovers that you can pass your mathematical plane.



Cindy Hain

Charity-Begins-at-Home Computing

by Hesh Wiener

If you're reading this, you're probably not blind, and you probably have a home computer. So why not use your home computer to bring an article to the blind. You can do it, more easily than you think. I know. I've done it.

Before I go into what I and a few other dedicated people have done, I want to assure you that my suggestions do not require the kind of devotion Dr. Livingston brought to lepers.

I'll just share a few tricks, which you can probably surpass, that will enable you to use your home computer to make life a little more exciting and enjoyable for some special people—people who lack sight or hearing. In doing so, you will become special for them and, more importantly, for yourself.

If you do decide to try working with the blind or deaf, you will embark on a path that you will never retrace. Your social and political views will be permanently altered. For the first time you will be forced to recognize that people with whom you can't readily communicate are not necessarily stupid or even ignorant. You will be forced to conclude, after your experience, that you must reconsider your judgment of everyone you think is somehow out of it. This may include such diverse people as cops, teachers, your parents, younger siblings, residents of foreign countries, the poor, devotees of unfamiliar religions, communists, and overworked plain middle-class people.

Despite your wishes not to be uncharitable, you will find that some blind persons and some deaf persons are in fact slow to learn, disinterested in whatever turns you on, or, as far as you are concerned, people you simply don't like—just like people who are not handicapped. That is the point. All people are a lot like other people. You and me, too.

If you try working with the blind or deaf, you'll embark on a path you will never retrace.

Now to get down to the nitty-gritty.

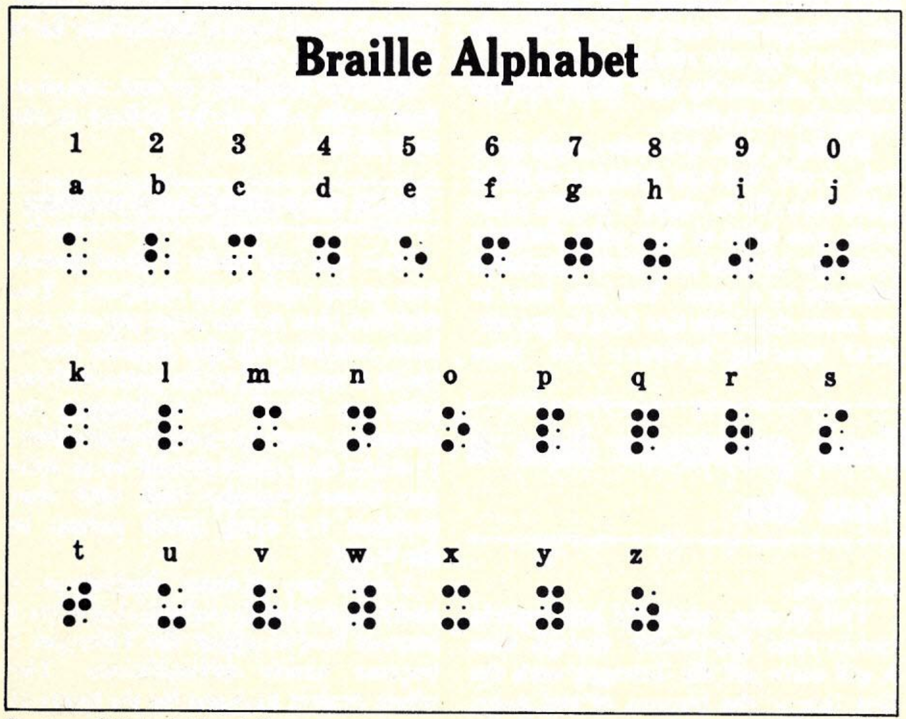
MAKING A BRAILLE TERMINAL

A Braille terminal can be made from an ordinary model-33 Teletype if you have a home computer to make the Teletype smart.

First you get the Teletype. Then you remove the little cylinder that has all the letters on it. You will notice that there are four rows of letters, each with sixteen positions.

Drill three holes about one thirty-second of an inch in diameter in every other column of letters. The middle hole should be halfway up the cylinder. The other holes should be about an eighth of an inch directly above and below the middle hole. All the holes should go straight in (they are perpendicular to the surface at the point at which they are drilled). Make them about an eighth to three-sixteenths of an inch deep.

Get some little metal pins or pieces of solid wire that will fit into the holes snugly. Stick them in the holes with epoxy or that super-duper glue stuff. Trim the pins about one-sixteenth to one-eighth of an inch above the surface of the cylinder, evenly. Grind



Courtesy of Victor S. Hemphill

Basic Braille Vocabulary

about	ab	and	⠯	blind	bl	conceive	concv	ence	⠰⠑
above	abv	ar	⠜	braille	brl	conceiving	concvg	enough	⠢
according	ac	as	⠵	but	⠃	could	cd	er	⠻
across	acr	ation	⠠⠝	by	⠴	day	⠐⠙	ever	⠐⠑
after	af	bb	⠆	can	⠉	dd	⠲	every	⠑
afternoon	afn	be	⠆	cannot	⠸⠉	deceive	dcv	father	⠐⠋
afterward	afw	because	bec	cc	⠒	deceiving	dcvg	ff	⠖
again	ag	before	bef	ch	⠡	declare	dcl	first	fst
against	agst	behind	beh	character	⠐⠡	declaring	dclg	for	⠿
ally	⠠⠽	below	bel	child	⠡	dis	⠲	friend	fr
almost	alm	beneath	ben	children	chn	do	⠙	from	⠋
already	alr	beside	bes	com	⠤	ea	⠂	ful	⠰⠇
also	al	between	bet	con	⠒	ed	⠫	gg	⠶
although	alth	beyond	bey			either	ei		
altogether	alt	ble	⠼			en	⠢		
always	alw								
ance	⠨⠑								

the ends smooth.

However, don't put pins in all the holes. In one set of three holes, don't put any pins. In the next set, put just one at the bottom. And so on until, going around the cylinder, you have pins forming successive binary numbers 000 through 111.

Put the cylinder back on the Teletype. You are halfway through.

Remove the platen (the rubber roll that backs the paper) and cover it with gum rubber tubing. The tubing is called surgical tubing, and it may be obtained at the supply houses from which physicians and hospitals buy equipment. When you go to buy the tubing, take the platen along so you can get tubing that will just stretch a little as it fits over the original hard rubber surface. You want a smooth platen but not one that will tear.

Ten to one your blind partner has a lot better ear than you do.

Now you have a machine that can make dents in paper in a three-bit binary code. You will have to fiddle with the Teletype and maybe grind the pins slightly to get the thing to work right, but it's obvious by now what you are trying to accomplish.

Braille is a six-bit code. Each symbol, or cell, has two columns of three spots each. So to make a Braille character, you have to make the Teletype print two of your new dent characters followed by a space. You also have to use more than one-line feed to get vertical spacing between the rows of Braille.

This Braille, while it's not superb, can be read. Remember, though, that it will come off the Teletype with the first line at the bottom of the page, because it is actually being embossed backwards by the mechanism. To be read, it must be placed on a flat surface. You can simply pull the paper forward if you have a flat surface for it on top of the Teletype.

Use your computer to look ahead so that words will not be broken at the ends of lines.

ONCE THE BRAILLER WORKS

Now you can invite a blind person over to use your home computer. You will find that at first your partner will have trouble with this Braille, but it really is readable, so be patient. Soon your new friend will be hogging the computer, and that may be a problem. I reckon that there should be at least one home-computer buff with that problem for every blind person in the world.

I built one of these doohickeys. I had help getting it working, but after I learned how to adjust the Teletype, I became nearly self-sufficient. The whole project took maybe six hours of

Courtesy of Victor S. Hemphill

gh	⠣	itself	xf	must	mst
go	⠛	ity	⠰⠽	myself	myf
good	gd	just	⠚	name	⠐⠝
great	grt	know	⠐⠅	necessary	nec
had	⠸⠓	knowledge	⠅	neither	nei
have	⠓	less	⠨⠎	ness	⠰⠎
here	⠐⠓	letter	lr	not	⠝
herself	herf	like	⠇	o'clock	o'c
him	hm	little	ll	of	⠷
himself	hmf	lord	⠐⠇	one	⠐⠑
his	⠦	many	⠸⠍	oneself	onef
immediate	imm	ment	⠰⠞	ong	⠰⠛
in	⠔	more	⠍	ou	⠳
ing	⠬	mother	⠐⠍	ought	⠐⠳
into	⠔⠖	much	mch	ound	⠨⠙
it	⠭			ount	⠨⠞
its	xs				

> **Deaf people develop poetry in sign language that is quite beautiful.**

tinkering and an hour each for programming and adjusting the thing before it worked. I did not have a home computer, so I drove it with a BASIC system that was set up for time sharing, one that had nice string commands for turning our Braille patterns.

If you find you want to Braille a lot of stuff, like a BASIC manual or your local newspaper, you may be able to use your home computer to get the job done wholesale. I'll cover that soon.

MUSIC FOR THE BLIND

When I worked in a computer factory, we had a high-speed paper-tape reader we could start and stop real fast—so fast we could make it buzz out musical notes. It turned out that what was being played was the tape reader's swan song, "Death by Vibrator." But getting a home computer to make something buzz is trivial, and with a cheap amp or a little risk to your stereo, you can pipe that buzz out through a speaker. Presto, a music synthesizer.

When you get the hang of it and adjust to the rotten sound quality, you'll probably end up playing some Beatles or some Bach. If you have lots of output ports you can deal with rapidly, you can get into counterpoints and harmonies. The relative delay between almost simultaneous notes is a kind of attack variation. As for volume, that's another problem, one you might try to solve elegantly. One way you might make neater music is by hooking your home computer to the stereo through a digital-to-analog converter.

ROMtutorial ROMtutorial

Three-bit binary code: *The smallest unit of information is the binary bit—it is just on or off. Three bits have eight possible combinations. Remember, all off (or all 0) is a real combination.*

Six-bit code: *Six binary bits have sixty-four possible values. Notice that this is eight times eight, and that six bits consists of two three-bit codes. How many possible values will seven bits allow? Eight?*

High-speed paper-tape reader: *A mechanical device which can pull punched paper tape through it very fast and can give a computer a reading of the codes punched into the tape. Usually photo cells are used to read the punched tape.*

Digital-to-analog converter: *An electronic circuit which uses digital on-or-off electrical signals to control an electrical output which can have a wide range of voltage levels. It is hooked to a meter which shows the number represented by the bits of the digital signals.*

ROMtutorial ROMtutorial

Diskette: *A flexible plastic disk looking like a 45 rpm record, but coated with a magnetic film like recording tape. A computer can read or write information onto the diskette. Each diskette can hold approximately one-fourth million letters or numbers.*

Basic Braille Vocabulary (cont'd)

ourselves	**ourvs**	**quite**	⠟	**so**	⠎
out	⠳	**rather**	⠗	**some**	⠐⠎
ow	⠪	**receive**	**rcv**	**spirit**	⠸⠎
paid	**pd**	**receiving**	**rcvg**	**st**	⠌
part	⠐⠏	**right**	⠐⠗	**still**	⠌
people	⠏	**said**	**sd**	**such**	**sch**
perceive	**percv**	**sh**	⠩	**th**	⠹
perceiving	**percvg**	**shall**	⠩	**that**	⠞
perhaps	**perh**	**should**	**shd**	**the**	⠮
question	⠐⠟	**sion**	⠨⠝	**their**	⠸⠮
quick	**qk**				

If home-computer music is fun for you, imagine how much fun it is for a blind person. I think you'll have more fun yourself if you work with a blind computer jock, because then you can both try to improve the music to please the tougher customer.

It's ten to one that your blind partner has a lot better ear than you do, particularly for that intangible stuff that gives music character. If you can see, all that data coming in through your eyes makes your sound consciousness recede, although you can bring it back with effort.

As you experience the effect of music and other noises more exquisitely, you'll discover forces you've never thought much about before. You'll understand why the music on the cheap transistor gives the beautiful creature on the next beach blanket goose bumps, while your witty repartee gets you a look at a sunburned back, notwithstanding your agony in a Speedo two sizes too small.

COMPUTER HIT PARADE

One of the oldest tricks for making computers sing is to put an AM radio near circuits that radiate signals. Electrical fields can be picked up by the radio, and they will come out as tones. Your computer probably doesn't radiate much, but a small radio (battery-powered for safety) sitting on the chassis may do the trick anyway. The radio then becomes your sound synthesizer. From varying the tones to playing songs is just a small step.

ELECTRONIC BRAILLE MAIL

The Protestant Guild for the Blind has a group called ARTS Services. ARTS has a mini-based computer utility for the blind, and one of the system's peripherals is a great Braille embosser. The terminals include small Braille embossers (like the one you might have built, but lots better) and voice synthesizers.

You can have access to this wonderful machine if you have a very good reason and maybe some money to pay for the services you use. The ARTS system must be self-supporting—and, if you think about it, it makes more sense that way, because then there's a better chance it will be replicated elsewhere.

You can access this system through a terminal or home computer if you have an acoustic coupler. The services ARTS provides will enable you to really do some neat things with blind persons even if they are not computer jocks. All you have to do is get a pile of text, call ARTS, and zip—Braille in the mail in a few days.

ARTS has editing software for Braille and regular text and a whole lot of other neat items.

Courtesy of Victor S. Hemphill

themselves	**themvs**	**tonight**	**tn**	**whose**	⠘⠱
there	⠐⠮	**under**	⠐⠥	**will**	⠺
these	⠘⠮	**upon**	⠘⠥	**with**	⠾
this	⠹	**us**	⠥	**word**	⠘⠺
those	⠘⠹	**very**	⠧	**work**	⠐⠺
through	⠐⠹	**was**	⠴	**world**	⠸⠺
time	⠐⠞	**were**	⠶	**would**	**wd**
tion	⠰⠝	**wh**	⠱	**you**	⠽
to	⠖	**where**	⠐⠱	**young**	⠐⠽
today	**td**	**which**	⠱	**your**	**yr**
together	**tgr**			**yourself**	**yrf**
tomorrow	**tm**			**yourselves**	**yrvs**

But ARTS is really very busy. You shouldn't call them, you'll disturb the people running things, who already have their hands full. And you shouldn't even write to them unless you are seriously interested. But if you are sincere, the person to contact is Peter Duran, ARTS Services, Protestant Guild for the Blind, 456 Belmont Street, Watertown, MA 02172. If you have a specific project in mind, tell him simply and clearly what your idea is. He will let you know if he and his colleagues can be of help.

If you're doing interesting things with blind persons, things that have nothing to do with ARTS, Mr. Duran would appreciate a letter about that, too. The people at ARTS are always looking for new ideas to improve what the service and its users are doing.

SO THE DEAF MIGHT HEAR

Computers are a natural for the deaf. For one thing, computer languages aren't spoken, so the deaf can be as proficient at them as those who can hear. But working with the deaf can be harder than working with the blind. This is particularly true of persons whose deafness began early in life, because they have problems speaking clearly.

Nevertheless, one can learn to understand most deaf people. Be patient and ask your deaf friends to write out anything you can't understand.

One small digression before we get into the sound-oriented stuff you can do with your computer: persons who can neither hear nor speak may still have a good sense of rhythm. These persons develop poetry in sign language that is quite beautiful, something the hearing can learn if they try. If all this sounds weird, think again. Hula and other South Sea dances are built around rhythmic sign languages. Take away the ukelele and you have a next cousin of a deaf person's poem!

Now, with computers, the deaf can carry on telephone conversations.

There are many people with severe hearing loss who are not completely deaf. Their hearing loss may keep them from some activities, but it will not stand in the way of any of your favorite computer stuff—except computer music. So I'm going to suggest something you can do with deaf persons that is a little out of the ordinary.

COMPUTER CB

One nice thing to do if your home computer can send data over phone lines is to help the deaf use it as a communications medium. The deaf mainly depend on written communication. But now, with computers, the deaf can carry on live conversations at a distance—something they really miss.

To provide text telephone service (computer CB), all you really need is a terminal, but a whole computer can make things a lot more interesting.

First you need a computer CB conspiracy. This magazine and other journals and newspapers are the places to put ads to start your network. The buddies you meet via computer CB links will be, no doubt, the kind of friends you really want.

Once you open your home to the deaf, you will find that you do not want to tie up your rig with keyboard plunking all day, nor do you want to run up really high phone bills. Storage devices and high-speed transmission links will save you lots of trouble and money: your computer can take in a message even while it's doing other things with you, and some home computers can support several terminals at once. When messages are on your diskette or tape—a quick call and they're gone.

From an occasional message, your computer CB for the deaf will evolve to networks, bucket brigades, and other organizational structures. Messages will begin to acquire addresses. It might be nice if some, like love notes, were encoded so they could change hands without becoming public.

If you advertise and start doing a big business—one that requires you to collect the cost of the phone lines—you will be breaking the law. You will have become a common carrier, sort of. Now that you're an outlaw, you'll have even more fun.

Do you really think the FCC and Ma Bell will swoop down and pull the plug on your deaf-persons electronic mail service? Not on your life! But if it turns out that you do get into trouble with the law, here are a couple of people to whom you can write:

President Jimmy Carter. My guess is that he will encourage you and kick the FCC or whoever is on your back right in the goober. Uncle Sam has a

Courtesy of Victor Hemphill

Basic Braille Punctuation

accent sign	⠈
apostrophe ’	⠄
asterisk *	⠔⠔
bar /	⠌
bracket (or brace) [opening	⠠⠶
bracket (or brace)] closing	⠶⠄
capital sign, single	⠠
capital sign, double	⠠⠠
colon :	⠒
comma ,	⠂
dash —	⠤⠤
decimal point .	⠨
exclamation point !	⠖
fraction-line / or —	⠌
hyphen -	⠤
italic sign, single	⠨
italic sign, double	⠨⠨
letter sign	⠰
number sign #	⠼
parenthesis, opening (	⠶
parenthesis, closing)	⠶
period .	⠲
question mark ?	⠦
quotation mark, double, “ opening	⠦
quotation mark, double, ” closing	⠴
quotation mark, single, ‘ opening	⠠⠦
quotation mark, single, ’ closing	⠴⠄
semicolon ;	⠆
termination sign	⠠⠄

big heart and a dumb bureaucracy. If the blind get free mail, the deaf should get free computer CB, and that's that.

Senator Bob Dole. President Ford's running mate is really involved in legislation to help the handicapped. Unbeknownst to most of you who watched the Mad-Ave.-image stuff during the campaign, Senator Dole is a pussycat. Tough on political adversaries, he's usually on the right side when it comes to people things like this. And if you are doing something interesting with your home computer and the handicapped, he'd love to hear from you.

While I'm on the subject of people to write to, you ought to know about Dr. Steve Jamison at IBM, 2670 Hanover Street, Palo Alto, CA. He's a very busy man who has done a lot to organize IBM's terrific program for the deaf.

Get in touch with Dr. Steve if you want to bring your home computing experience with the deaf into your place of business. He's really sharp on that stuff, and you'll be amazed at all the things he's learned about the deaf and the way big corporations can make room for them.

Explain what you're up to, simply and clearly, give him a chance to answer, and you'll be surprised at the stuff he can pass along to you. His work will make you understand why it is so hard to accommodate the deaf in business and why you can get it to happen anyway.

A PAUSE

I've really oversimplified everything in this article. There are a few reasons for that, and I thought I'd pass them along while I've got your attention.

- I think everyone with a home computer should know what can be done with it that's of social value, even if they can't actually do much right now themselves.
- I don't understand all the subtleties of this stuff myself. I worked with blind people for about an academic year, and my experience was more important for me and my blind friends than for science or the handicapped in general. Expect no more yourself, and you'll be amply rewarded.
- Your biggest problem will be accepting the blind or deaf as people. I was oversensitive at first, and you will be, too. It goes away.

  But don't be surprised if the first time you say "you see" to a blind person you get a sinking feeling in the pit of your stomach. Most blind people know how to put their neurotic friends at ease. Seek their help.
- I think that you should get safety advice elsewhere, but do get it before you mess around.
- Experimentation is better than lots of direction in almost anything that can't prove fatal.

THE COMPUTER WINDOW

I think I owe you a warning. Once you get involved with this kind of stuff, it will ruin a lot of the fun you've been having with your home computer. Fantasy is fine, but the things I'm writing about are a lot farther out than Star Trek because they're real-life experiences. Once you use your home computer as a window, not a mirror, you'll never be able to preen your ego in it with quite the same satisfaction.

And if you're not turned on by these zany ideas, don't worry. Not everybody wants love. Some people are happier with skinflicks. ▼

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HOME COMPUTERS

here today, everywhere tomorrow

by Richard W. Langer

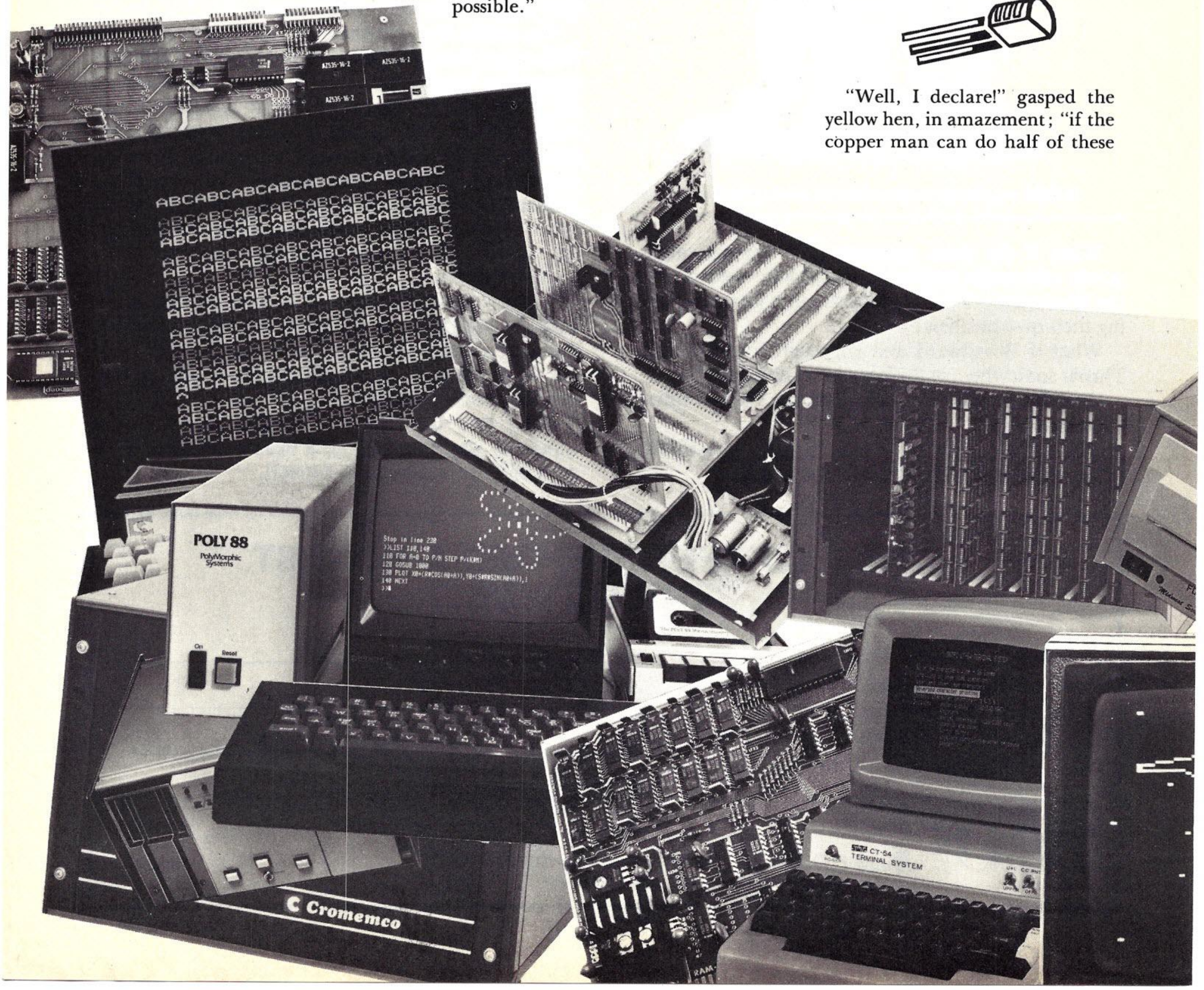
One dark night in the mid-50's, young Bernard Katz was sitting in front of the television with his family. The educational program they were watching centered on a huge, room-filling computer and what it would do to shape the future of industry and mankind. Staring in silent fascination till the program's end, Katz announced, "Someday I'm going to have a computer like that."

His mother smiled indulgently. "Dear, I don't think that's really possible."

Today Bernard Katz has his computer. It cost him under a thousand dollars, not counting the input terminal and the video display screen, it's the same size as his stereo, and it has more computational power than a million dollars could buy back in the mid-50's.

* * *

"Well, I declare!" gasped the yellow hen, in amazement; "if the copper man can do half of these


AZ535-16-2
ABCABCABCABCABCABCABCABC
POLY 88
PolyMorphic Systems
On
Reset
Cromemco
CT-64
TERMINAL SYSTEM
RAM

```
Stop in line 230
>LIST 110,140
110 FOR A=0 TO P/H STEP P/(K*H)
120 GOSUB 1000
130 PLOT X0+(R*COS(A0+A)),Y0+(S*R*SIN(A0+A)),1
140 NEXT
>
```

> things he is a very wonderful machine. But I suppose it is all humbug, like so many other patented articles."
>
> "We might wind him up," suggested Dorothy, "and see what he'll do."
>
> *The Wizard of Oz*
> L. Frank Baum

The brain of today's home computer, if one may be so anthropomorphic, is the microprocessor. This is an electronic chip similar to that replacing the clockwork in a digital watch, the difference being one of complexity. The chip in the watch is equivalent to a couple of handfuls of transistors; in LSI (large scale integration), each chip is equivalent to 3,000, 4,000, or more transistors, the whole end result being no bigger than your fingernail.

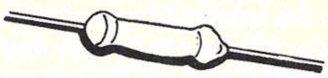
The microtechnology behind this feat is extremely diminutive in scale. Each chip is built up on an almost atom-to-atom basis. And if it all seems hard to grasp, you have plenty of company in your puzzlement—microprocessors are inherently incomprehensible devices to all but the few hundred people who design them. Even an electronics engineer can define one only in terms of size, power, and capabilities. The best the rest of us mortals may hope for is to understand what it is capable of doing in our day-to-day lives.

It can, for instance, put every Mom-and-Pop retailer on an equal computer footing with the telephone company and Con Edison. That's the business angle. On the personal side of the ledger, what it can do is balance your checkbook, figure out your income tax, control the heat and humidity in your house to keep down the utility bills, water your plants, organize your shopping to keep your larder stocked and balanced, remind you to send Aunt Tillie a birthday card on the appropriate date, teach your child mathematics, make stock market projections, monitor the home for fires (and call the firehouse), intercept intruders, and, using computer graphics, rearrange your rooms and plan your dream house.

You can always learn programming yourself. It's not unlike doing a gigantic electronic crossword puzzle.

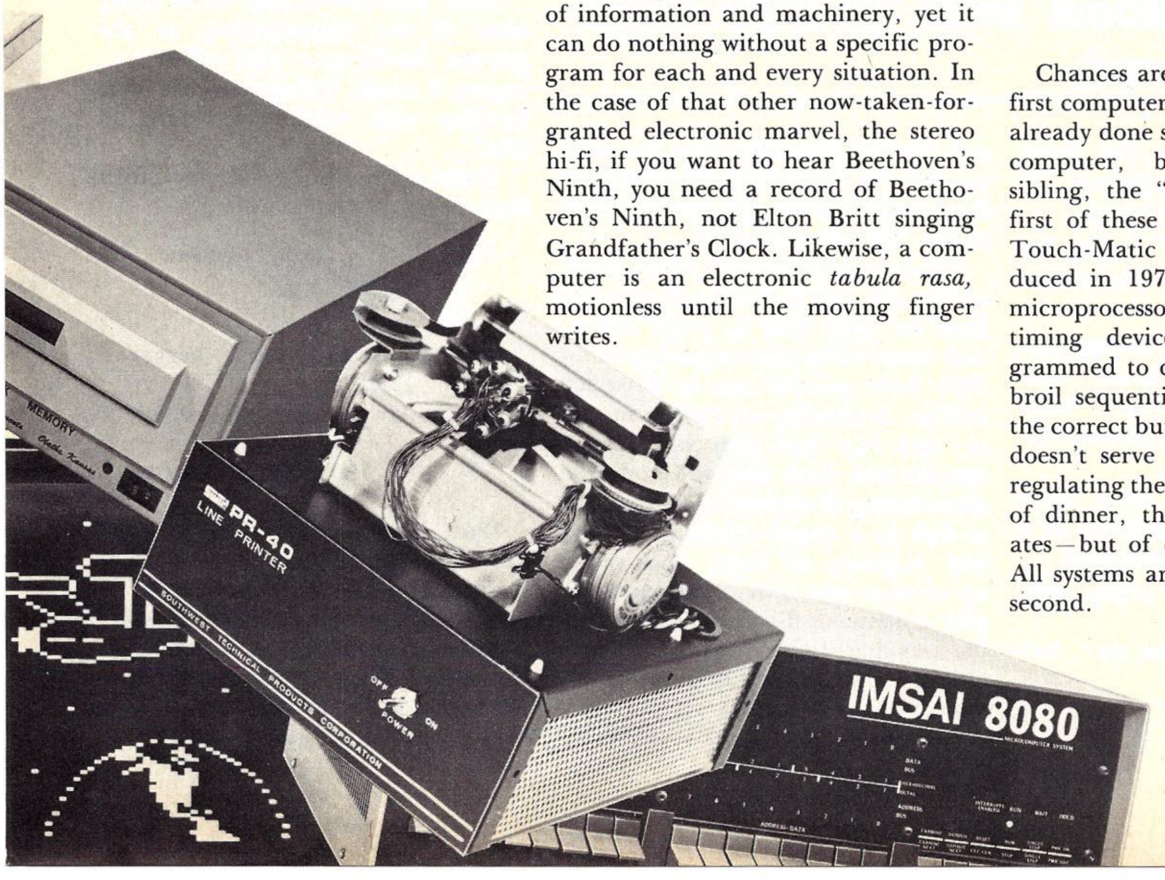
The computer is at one and the same time the most general-purpose and the most limited machine devised by the mind of man. It is capable of controlling an almost limitless amount of information and machinery, yet it can do nothing without a specific program for each and every situation. In the case of that other now-taken-for-granted electronic marvel, the stereo hi-fi, if you want to hear Beethoven's Ninth, you need a record of Beethoven's Ninth, not Elton Britt singing Grandfather's Clock. Likewise, a computer is an electronic *tabula rasa,* motionless until the moving finger writes.

The first thing you are apt to do with a brand new home computer is play games. It can play hundreds of games. To date the weakest link in computerizing every home in America has been providing the programs to make the computer do what all the different consumers happen to want it to do. But that situation is being remedied rapidly. If, today, it's easier to get a program for *Space War* or *Star Trek* than for checkbook balancing and recipe filling, well, wait a month. And if you can't wait, you can always learn programming yourself. It's not unlike doing a gigantic electronic crossword puzzle, once you get the hang of it. And after all, the kid down the street is doing it, isn't he?



> The distance from nothing to a little, is ten thousand times more, than from it to the highest degree in this life.
>
> *Sermons*
> John Donne

Chances are you will purchase your first computer this year, if you haven't already done so. Not a full-scale home computer, but its single-function sibling, the "smart" appliance. The first of these machines was Amana's Touch-Matic microwave oven introduced in 1975. Using an integrated microprocessor instead of mechanical timing devices, it could be programmed to defrost, heat, bake, and broil sequentially by simply pressing the correct buttons on the keyboard. It doesn't serve the dinner yet. Besides regulating the timing and temperature of dinner, the little computer operates—but of course—a digital clock. All systems are accurate to 1/60 of a second.



Drawings by Joanne Zeiger
Collage by Arlene Skarani

Play so that you may be serious.
Nichomachean Ethics
Aristotle

I'm down in Leslie Solomon's basement. As Technical Editor of *Popular Electronics,* Solomon has considerably more than a passing interest in home computers. Along with Solomon and myself are Lee Felsenstein of LGC Engineering, and Sol 20, the new microcomputer designed by Lee and manufactured by Processor Technology. It looks like an electric typewriter with nice walnut sides but no place to stick the paper. Lee, who looks like any typical college student, has just flown in from California with the first Sol (reputedly named after Solomon) off the production line.

As soon as the computer is on line and hooked in to the video screen, Lee and Solomon start playing *Star Trek 80,* the latest and most sophisticated version of this popular underground Kriegspiel computer game. On my first try at the controls of Starship Enterprise, it's zapped out of the universe by a phaser shot from the Klingons in five minutes. "Appropriate condolences will be sent to your family," the computer tells me. Second try and I lose the Enterprise in a space warp. After ten minutes I still haven't located it and discover my latest move has made the ship invisible. I'm flying blind with photon torpedoes all around. "This could take hours."

I'm flying blind with photon torpedoes all around.

"Hours? Days, years," replies Sol (the man), eager to take his turn on Sol (the machine).

But Lee, who like most teenage and post-teenage computer freaks "lives with nostalgia for tomorrow," beats him to the keyboard. Only accidentally to ram a star base.

Three hours later I leave them trying to beat Sol (the machine) at a 3-D tic-tac-toe game called Qubic.

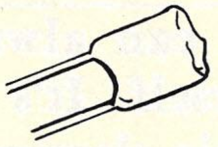
"And he starts some tricky nonsense."

"Obviously, if you take that, he's going to go there."

"He's got to go there."

"He did."

Microcomputer-controlled video games, compared to the small single-unit video games like Pong, hockey, and auto racing now being mass-marketed as the latest hot adult toys, bear the same relation of complexity as the Viking spacecraft to a unicycle. The present electronic video games represent strictly an interim state of the art, the 45's being rushed to market while the stereo 33's are being readied to take over.



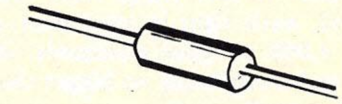
Amana's success with the consumer was all that was needed to unleash a flood of other "smart" appliances. Up till then the microprocessor was essentially a chip in search of a market. But now Singer is replacing the cams that control the stitching patterns of its sewing machines with a small internal computer. Chrysler has a computer under its hood, using it to control carburetion in some '77 models. Washing machines, blenders, refrigerators—they're all getting "smart."

Whether the new integrated appliances will be labeled "computer controlled" in advertising, or not, remains to be seen. Many marketing men feel the consumer views the word *computer* in a less favorable light than that in which he sees the pimp on 42nd Street. They may be right.

The leisure field, on the other hand, tackles the computer-image problem head on: play with it, you'll like it. And home-video-game sales figures for 1976 have printed out at $100-200 million, depending on whom you talk to, and how bad the chip crunch actually was. Soon sales will make the skyrocketing electronic calculator look as slow as a camel caravan. Yet the vast majority of these hook-them-up-to-your-very-own-television-and-play-at-home-as-if-you-were-down-at-the-neighborhood-bar games will be obsolete within a year, or at most two, after hitting the market.

Even jury-rigged to a TV screen instead of its own video terminal, a microcomputer costs five to ten times as much as the Fairchild Video Entertainment System, the most versatile of the home video toy sets. But whereas the Fairchild system is capable of six different games, with more on the way, the microcomputer can not only play an almost infinite number of much more complex games, it can run your house in its spare time—maybe even your life if you so choose.

The unannounced inroads of the computer into the territory of our daily lives are so rapid that the invasion is apt to be complete before the alarm is even raised. Getting a personal computer may well be the best defense.



Dr. Ronald McLachlan is a dentist. But that soft whirring you hear in his Anaheim, California office isn't some newfangled ultrasonic drill. It's his sympathetic Altair personal computer checking disbursement records, doing the billing and accounts receivable, and figuring a percentage of work performed in relation to McLachlan's production time—a sort of dentibyte unit pricing.

He has a few more tasks to assign the computer. Once they're taken over, so is all the paperwork in the office.

Since McLachlan had been doing most of the programming of the present bookkeeper-cum-efficiency-expert, I asked, "Of course, you were familiar with computers before all this?"

"I had never seen a computer until I went down and bought one."

Rich man, poor man, beggar man, thief,
Doctor, lawyer, merchant, chief,
. . . .
Old Nursery Rhyme

"Psst, want to buy a Lear-Siegler CRT cheap? Or how about a nice brand-new-never-used Z-80 CPU?" It hasn't reached TV and stereo proportions yet, but your neighborhood fence can spot a fast trend coming on the inside track. Hot computers are already part of his fleeting inventory.

As in politics, power is the name of the game in computers.

Combining the back-to-the-land urge with computers might seem like an exercise in contradiction, but to Joseph Scalet, Jr., a self-pronounced "technological junky" who lives on a five-acre cooperative minifarm in Lawrence, Kansas, it's not only perfectly logical, but it works.

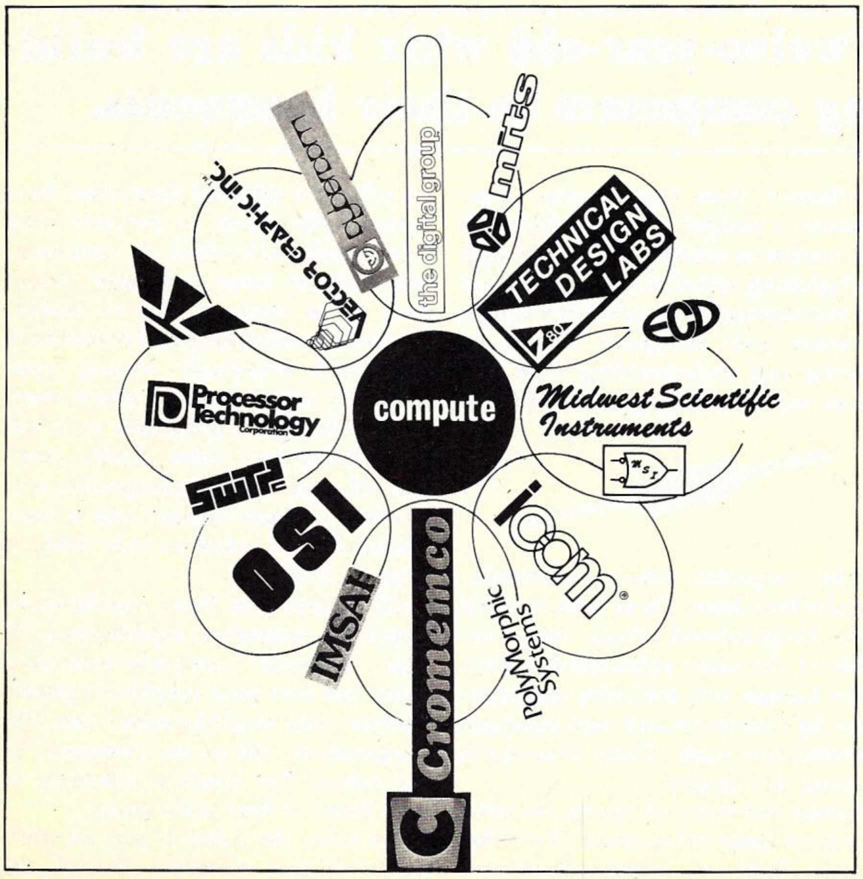
Now, unlike most of us, Scalet has his own gas well on the property. He also has two houses and two cottages, and only one water well. Water, particularly soft water, being scarcer than gas in his part of the country, there are cisterns to store rainwater collected from the roofs of the habitations. The gas well needs periodic draining; the roof-mounted water collectors need to be flushed as soon as the rain begins, otherwise the collected water will be full of dust and dirt; and if more than one person in the four houses takes a shower at the same time, the water pressure falls to near zero unless someone switches the pump to run continuously instead of on demand. Should that person forget to switch the pump back to demand afterwards, it will pump itself right out of existence. All of which keeps the residents rather busy running back and forth throwing switches.

At least that's how things stood until Scalet's home computer arrived. Now almost everything is automated, gas and water and all. Oh yes, the computer keeps a record of the activity, as well as coordinating the spray schedule for the orchard.It's the biggest electric-train set Scalet ever got for Christmas.

* * *

Edward Epstein grows orchids. He also travels a lot. Now you can't leave a whole plant collection in just anyone's care, so Epstein has put his computer in charge. Through a series of sensors and solenoids it completely controls the hothouse. Not only does it take care of such mundane tasks as watering the plants, but, equipped with a complete built-in calendar of sunrises and sunsets, it can compensate for short day-lengths by turning on supplementary artificial light; it even varies the light intensity with increases and decreases in temperature to maximize the plants' growth. Needless to say, it also controls humidity. Now if only it could pick off aged brown leaves as well. . . .

Edward Epstein represents that group of home-computer users who don't have time to become personally involved in setting up and programming their machines. His entire system was developed for him by Ray Eisenstark of Sirocco Systems in New York, one of a small but growing number of individuals who work on personal computing systems. As more and more computers are installed in the home, a multitude of little lemonade computer companies will no doubt spring up. Even now twelve-year-old whiz kids are building computers in their basements to run the world all over the place. They'd much rather develop a system to run their neighbor's house than sell lemonade or deliver newspapers to earn the money to keep themselves in computers.



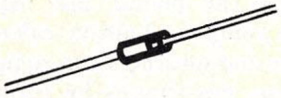
Arlene Skarani

* * *

Well I remember from high-school days, those who had typewriters always received an extra half point or so on their papers for neatness. Nowadays, students like Robert Powell in East Brunswick, New Jersey should be in clover. A sixteen-year-old high-school junior, Powell has not only the requisite typewriter, but it's hooked up to a home computer to do his editing as well.

He types a rough text into the computer, then makes any corrections or additions he wants on the video display terminal. Once he's satisfied with the draft, he inserts fresh paper into the typewriter and the computer bangs out a justified, letter-perfect paper. In its spare time, the computer is used for solving physics problems and running a model railroad with over 750 feet of track.

Your neighborhood fence can spot a fast trend coming on the inside track.



George Gilpatrick's computer kit arrived a couple of days before his first child. "Every visiting hour, I would call after a half hour or so," his wife Susan recalls, "to let him know it was visiting time. He always said, 'Just one more IC and I'll be there.'"

Time and computer will have their revenge. A year and a half later, after leaving George, Jr. in his grandmother's care for a few days, the parents returned from a short vacation. Susan Gilpatrick was somewhat saddened to see that although George, Jr. smiled, he did not rush to greet her. With his father it was different. Little George ran toward him all ecstasy. George, Sr. put aside the new video computer terminal he'd been carrying and bent down to scoop up the joyful child, only to be left standing alone as the joyful child headed for the video terminal instead.

The tale has a happy ending nevertheless. All three Gilpatricks now run The Computer Store in Windsor Locks, Connecticut, and all three spend their days playing with computers.

> In addition to exploiting the skills of robots, we should also allow them to have some fun, even occasionally at our expense.
>
> *The Psychology of Robots*
> Henry Block and
> Herbert Ginsburg

George is the forerunner of a whole new breed of electronic toys. I speak here not of George the minicomputer from Cincinnati Milacron, but George the voice-activated minivan from Imaginetics International, Inc.—George is a popular name among computerists, no doubt due to an association with "Let George do it."

George the van's guts contain an integrated circuit chip, along with some other not so fancy electronics. Talk to George and he does things you tell him to do. On voice command he goes forward or left or right, and he stops. You just sit in your chair and direct him.

George is both a breakthrough in the state of computer-robot art and in the process of becoming obsolete before being unleashed on the toy market. His prematurely aging, Janused condition is due to his reaction to tonal patterns rather than to truly discrete words. There are dozens of engineers across the country working on developing voice-controlled robots and speech synthesizers that respond to real words. None of them are talking to each other, so determining their progress becomes a matter of speculating in shadowy paranoia. But in fact some computer interfaces are already verbal, although their accent is somewhat foreign. Votrax, from that unlikely-named supplier Federal Screw Works, can say anything you want; you will be able to buy the obedient voice in kit form shortly. The Speech Synthesizer from Computalker Consultants, a similar vocal interface, hit the market at under $400. What with the lightning speed of developments in the microprocessing world, in a couple of years your computer should be hearing and understanding what you say as well as talking your ear off.

Twelve-year-old whiz kids are building computers in their basements.

The corporeal robot, meanwhile, has also been born. Or at least its arms have. Programmed robotic limbs capable of the same articulated motion as the human arm are being manufactured by Unimation and used in simple assembly line work. Their dexterity is growing day by day.

Limbs and voice, of course, do not a very personable robot make. Yet. One of the flock of sometimes-reticent robot researchers, Andrew Singer, a University of Massachusetts Ph.D. student, is sheltering himself from the world somewhere on Cape Cod in order to work on just that problem. "The hardware for implementing a robot, the servomechanisms and microprocessors, are already here," he assured me. What is lacking is the programs, the personality that will bring the electronic blood and guts to life. "A robot that you can tap on the shoulder and ask 'What are you doing?'—well, it sort of has to *know* what it's doing." And that's what Singer is working on, "a program that has some self-consciousness." His group expects to have "something up and running before '77 is out, hopefully sooner."

That something will be a robot linked by transceiver to the home computer, something you can play and interact with. It will respond to such commands as "Get out of this room" rather than simply "Go forward." To do that, it has to figure out all by itself where, in which of several directions, and how far to go, and it has to inform itself when to stop. Now there's a thinking man's robot.

This obliging mechanical companion will have infrared directional heat sensors with which to perceive, and twin aerials with which to communicate with the home computer, where most of its memory will be stored. When the robot has once scurried back and forth senselessly sensing your rooms, it will remember where every piece of furniture is located, so it will never bump into them. Surely someone will next design a compatible self-powered vacuum cleaner and a lawn mower for the robot to ride while it does the chores.

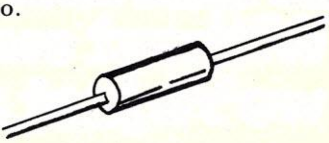
Of course, the legal ramifications would be somewhat superhuman. If your personal computer-controlled robot ran over your neighbor's poodle in error, who would be sued—you, the programmer, the power company, or the robot? But that's a dilemma at least three or four years away.

For now, the robot is just an ordinary toy that scampers around the room when it feels like it—and works up an appetite. Hunger, for this computerized pet rock, is defined in terms of batteries running down, at which point it scurries over to an outlet and plugs itself in. Red when angry, blue when calm, its repertoire includes the fad quality of the mood ring. (Exactly what makes it angry is part of the program not yet decided upon. Jealousy toward a live animal might be a suitable idea.) The Electronic Pet even has its own unpredictable biorhythm. About the only things you won't have to worry about with this pet are litter boxes and getting too many. The Electronic Pets will be programmed to play with each other, but nobody's working on multiplication.

Somewhere out there is Robert Coleman. He invented a plastic skin for dolls that's supposed to be so real that with your eyes closed it feels like flesh. I can't locate him.

A three-dimensional video terminal is about to hit the home-computer market. Based on the research of a small defense contractor, it will permit you to view and create 3-D pictures on the tube. It will let you design creatures that never were and never will be and make them dance to your piper's tune.

Couple it with an ultrasonic scanning wand connected to your computer, and you will be able to look inside people (if you are so inclined), boxes, and other sealed objects to discern the contents without opening them up, everything displayed in the round. The resolution will not be quite good enough to determine fine detail, nor will it perceive color. However, scanning a gift-wrapped box, you will be able to tell the difference between, say, a TV set and a Cuisinart. The scanning wand is already available, the three-dimensional video terminal should be on the market with a price tag under $300 by next year. Peek-a-boo.



In New York the stamp of legitimacy for almost any radical or slightly fringy intellectual enterprise is apt to be a course at the New School. The personal computer gets New School certification with the initiation of course #4848, "Home Computers For Your Own Use," which began in Feb-

GARBAGE IN GARBAGE OUT
SYSTEM UP AND RUNNING
SIMULATED LOGIC
COMPUTER WIDOW
red-orange
yellow
gold
shirt color rose
COMPUTER T-SHIRTS
colorful all cotton $5 each

name
address
city state zip
mail to MARTHA HERMAN 114 W. 17 STREET NEW YORK 10011 (212) 691 2821

quantity	chest size	design	$
add .60 per shirt for shipping			
total enclosed			

ruary. Billed as "the course you always wanted to take but couldn't find," its purpose "is to introduce the uninitiated to the world of affordable computers ($80-$5,000). No prior knowledge of computing is necessary."

* * *

Progress imposes not only new possibilities for the future but new restrictions.

The Human Use of
Human Beings
Norbert Wiener

If you like junk mail, you're going to love junk phone calls. And you'd better believe they'll be high on the direct sales, catch-them-while-their-pants-are-down hit parade for 1977.

Recently I spotted a small classified advertisement: *"Talking Computer.* Replaces live phone rooms at a fraction of their cost. Call for demonstration." Call I did, and spoke with one Reed Crawford of Texas Telephone Communication. Either that or his computer had a southern accent. Whoever or whatever answered had no appreciation for journalists. Short of flying to Texas and breaking down his/its door, I wasn't about to get a demonstration. I did find out that the system would dial numbers by geographic / income / family - member parameters and talk to whomever answered. Not just to say hello.

Another system is designed specifically for real estate salesmen. A minicomputer not much larger than your home model is reported to employ an optical scanner to read phone books and call prospects within a given proximity of a property for sale. It generates a sales pitch geared to the particular person answering. (How will it know my wife's name?)

Of course, you can always have your own computer screen the calls. This entails merely the problem of programming yours so it hangs up on theirs. The problem puzzles only an amateur, naturally; a real computer buff would probably program his to return a signal to "bomb" the other computer by fouling up its memory.

* * *

I thought about writing a Constitutional amendment to allow a computer to become President.
Sam Ervin, Jr.

One glimpses for a moment a porcine man sunk in a chrome Le Corbusier chair, rubbing his hands and staring with beady blank eyes across the pulsating apartment where the pets are being fed by the robot nursemaids, the dinner is being cooked while the rugs vacuum themselves, and the telephone is busy chatting with someone else's.

At last the human spirit within stirs and the man follows suit. Enough is enough. He's going to do it. He's going to pull the plug! The question is, does anyone remember where the plug is any more? In fact, did anyone really know where the plug was in the first place? ▼

Without our software, we're just another flasher.

Let's face it. No microcomputer is worth a dime if you can't make it work. Even E&L's Mini-Micro-designer would be just a "light flasher" if it weren't for our software system.

But the fact is that our tutorial software is the best in the business. Not just a pathetic rehash of chip manufacturers' specifications. But a clearly written, step-by-step instruction that teaches you all about the microcomputer. How to program it, how to interface it, how to expand it.

The teaching material is written by Rony/Larsen/Titus (authors of the famous Bugbooks). It's called Bugbook V. And it teaches through experiments designed specifically to get you up to speed on our Mini-Microcomputer (MMD-1). *And you don't need any prior knowledge of digital electronics!*

The best news? E&L's MMD-1 costs $422.50* in kit form, including all software and teaching material. And now it's available locally from your nearest computer store. Stop in today and get the whole picture. MMD-1. The finest microcomputer system on the market.

*Suggested resale price U.S.A.

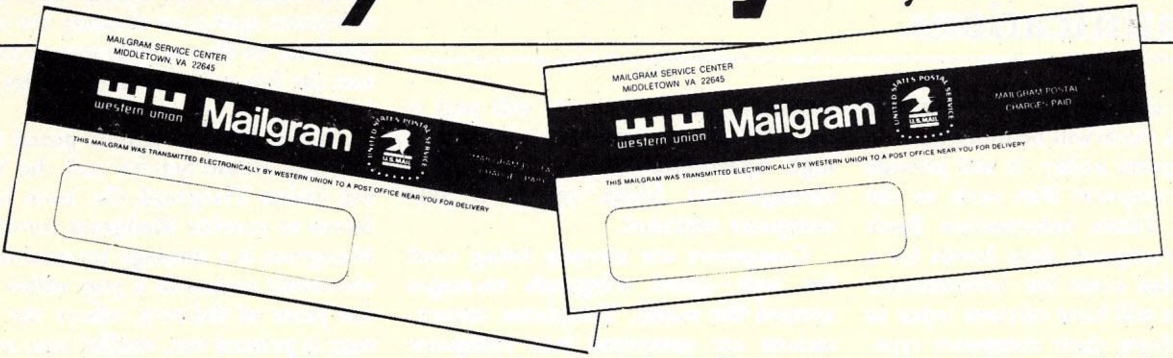
E&L

E&L INSTRUMENTS, INC.
61 First Street, Derby, Conn. 06418
(203) 735-8774 Telex No. 96 3536

Dealer inquiries invited.

ASCII/Telly

by Robert Osband


MAILGRAM SERVICE CENTER
MIDDLETOWN, VA 22645
western union
Mailgram
U.S. MAIL
THIS MAILGRAM WAS TRANSMITTED ELECTRONICALLY BY WESTERN UNION TO A POST OFFICE NEAR YOU FOR DELIVERY
MAILGRAM POSTAL CHARGES PAID

Communications means different things to different people. It means a phone call across town, a telegram across the nation, or newspaper dispatches from the other side of the world. To computerists communications generally means the transfer of information. This can be anything from transferring information to a central processing center to the return of processed data and reports.

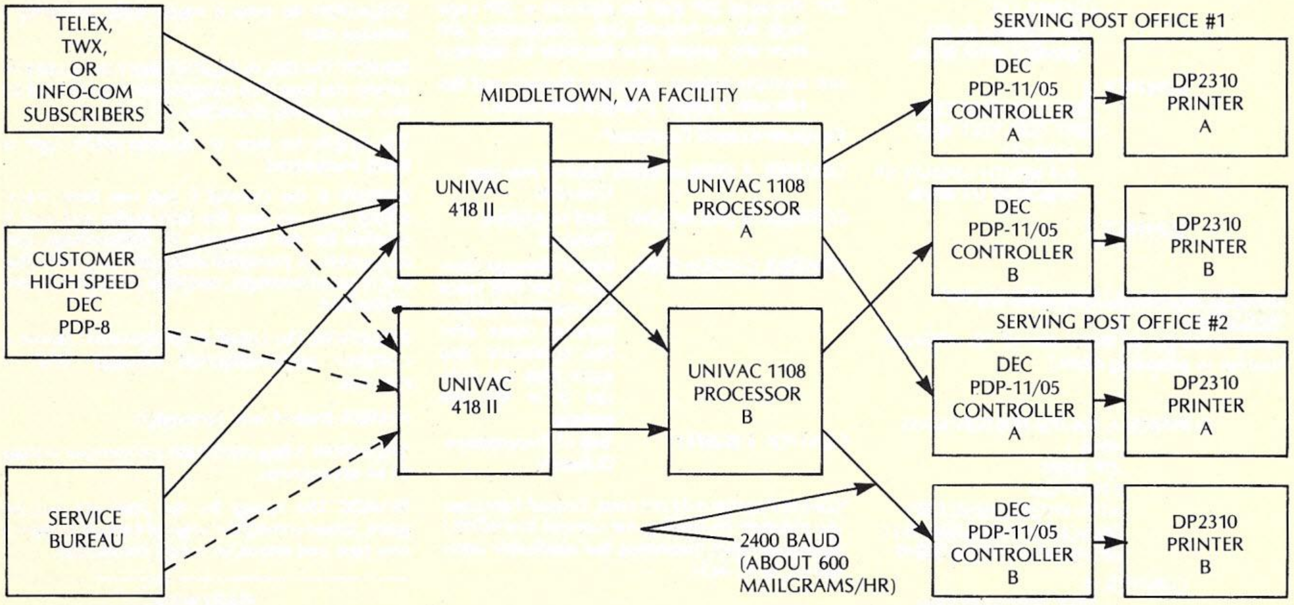
The advance of digital communications technology will probably bring about the Computer Utility Mailbox. Local computer utilities will spring up all over the country bringing computer services to the general public, including the electronic mailbox. This sort of thing is now in use in the ARPANET, an inter-university computer network operated by the Advanced Research Projects Agency (ARPA).

In the ARPANET, each user has a net name, usually the person's first name or nickname. Mail is addressed using the MAIL program each computer has in its system library. The address line includes the addressee's home-computer mnemonic, as well as the person's net name. When the user comes on line with his/her home computer, the MAIL program, which for delivery is part of the LOG-ON program, comes up and informs the user that there is mail for him/her. The mail can then be seen on the CRT or printed on the teleprinter terminal.

On systems that are single-user environments (such as home computers with modems) and smaller university time-sharing systems, programs can normally be found as user's names which are actually messages for people. I once found a file on a university's system disk named "party." It was an invitation to any computer programmer, hacker enough to look at the file, to come to a party the following Saturday.

As people become more familar

GENERALIZED MAILGRAM MESSAGE FLOW


TELEX, TWX, OR INFO-COM SUBSCRIBERS
CUSTOMER HIGH SPEED DEC PDP-8
SERVICE BUREAU
MIDDLETOWN, VA FACILITY
UNIVAC 418 II
UNIVAC 418 II
UNIVAC 1108 PROCESSOR A
UNIVAC 1108 PROCESSOR B
SERVING POST OFFICE #1
DEC PDP-11/05 CONTROLLER A
DP2310 PRINTER A
DEC PDP-11/05 CONTROLLER B
DP2310 PRINTER B
SERVING POST OFFICE #2
DEC PDP-11/05 CONTROLLER A
DP2310 PRINTER A
DEC PDP-11/05 CONTROLLER B
DP2310 PRINTER B
2400 BAUD (ABOUT 600 MAILGRAMS/HR)

Individuals can tie into the Mailgram system through TWX, Telex, or Western Union. With high-speed larger messages, the tie-in can be through magnetic tape and Digital Equipment Corporation's PDP-8. Then the Middletown, Virginia service center's 418IIs and UNIVAC 1108s process messages and transmit them to local post offices.

The home computer operators of today are in the forefront of the new communications.

with using computers in schools and universities, there will be more interest in the computer utility. It will provide access to computer files such as the New York Times Information Bank and other computer data banks for a base fee plus costs for information. Newspapers will have editions input to the utility from their computer typesetting tapes, and people will pull it into their home terminal's memory at high speed for later consumption through the home television set/computer terminal.

Computers are already being used for high-speed telegraph messages around the world. Telephone conversations are converted into computer codes to ease their transmission. From this, considering the recent advancements in microcomputers, it's only a short jump to data-communications equipment in the home. The home computer operators of today are in the forefront of the new communications, and the life style of tomorrow isn't far behind.

As for actual electronic postal mail, the U.S. Postal Service and the Western Union Telegraph Co. have joined forces to provide Mailgram service. A Mailgram is a message transmitted by electronic means to a post office near the point of delivery, where the message is printed out, stuffed into an en-

Mailgram formats for TWX

Figure 1.

1. Prepare your tape using the appropriate format.
2. Dial 910-420-1212. The computer will identify itself, activate your answer-back, and give a connection number.

```
WU ISCS
ALERCO CGO
004322A061 1420 EST
```

3. Transmit your tape. Stop tape reader following Control C and wait about 9 seconds for a complete acknowledgment from the computer.

```
ACCEPTED
00001
1-PC
```

EXAMPLE OF A SINGLE MAILGRAM

```
CONTROL A 001 CHICAGO ILL MAR 1
          ZIP 07430
          GEORGE SMITH
          J. JONES CO.
            225 FRANKLIN RD.
            RAMSEY NJER 07430
CONTROL B
          TEXT TEXT TEXT TEXT
          TEXT TEXT TEXT TEXT
            ALER CO
            427 SOUTH LASALLE ST
            CHICAGO ILL 60606
CONTROL C
```

EXAMPLE OF A MULTIPLE-ADDRESS (MA) MAILGRAM
(Same message to maximum of 50 addresses. Number in ascending order.)

```
CONTROL A MA 002 BOSTON MASS
          MAR 1
          ZIP 32015
          J WITT CO
          ATTN ENGINEERING DEPT
          136 SOUTH EVERGREEN AVE
          ORLANDO FLORIDA 32015
CONTROL B
          TEXT TEXT TEXT TEXT
          TEXT TEXT TEXT TEXT
            M BROWN CO
            130 STATE ST
            BOSTON MASS 01730
CONTROL C
CONTROL A 003 BOSTON MASS
          MAR 1
          ZIP 01730
          J LAWLOR CO
          PROGRAMMING SECTION
            637 CONGRESS ST
            BOSTON MASS 01730
CONTROL B
CONTROL A 004 BOSTON MASS
          MAR 1
          ZIP 49701
          E COLE CO
            8001 SEVEN MILE DRIVE
            DETROIT MICHIGAN
            49701
CONTROL B
CONTROL C
```

LEGEND

ZIP	The word ZIP and the destination ZIP code must be on second line. (Destination ZIP must also appear after the state in address.)
MA	Multiple-Address indicator (Precede and follow with a space. Transmit only once.)

Computer Control Functions*:

CONTROL A (SOH or SOM)	Start of Message Character
CONTROL B (STX or EOA)	End of Address Character
CONTROL C (ETX or EOM)	End of Message Character. Transmit twice in a Multiple-Address message: once after the signature and again after the Control B in the last address.
CONTROL S (X-OFF)	End of Transmission Character

*Control Functions do not print. Control Functions are obtained by holding the Control Key (CTRL) depressed while depressing the applicable letter key (A, B, C, or S).

FEATURES

☐ You can send up to 50 single address MAILGRAMS on one connection. (The messages must be numbered in ascending order.)

☐ You can transmit up to 2500 text words (15,000 characters) on a single connection.

☐ You can interrupt transmission for up to 9 seconds without being disconnected.

☐ You can send up to 4 lines of name-to and address between the zip code line and the Control B.

☐ You can have up to 40 characters in each line of address.

☐ You can obtain an immediate acknowledgment by sending Control S after Control C in the last message on a single connection or after the Control C in the last address of a multiple-address message.

REMEDIAL PROCEDURES

SITUATION An error is made while preparing a message tape.

REMEDY The DEL or RUBOUT key can be used to correct the tape. The computer is not affected by this non-printing character.

SITUATION An error is observed while tape is being transmitted.

REMEDY If the Control C has not been transmitted, you can stop the tape reader and wait 9 seconds for the computer to acknowledge and disconnect; a corrected message tape, including any rejected messages, can then be sent on a new connection.

SITUATION The circuit is disconnected before a complete acknowledgment (through 1-PC) is received.

REMEDY Resend your message(s).

SITUATION A Rejection Notice is received instead of an acceptance.

REMEDY The reason for the rejection will be given. Either correct the original tape or prepare a new tape and resend on a new connection.

ASSISTANCE
Contact the Computer Center Via TWX by dialing
710-822-1953
or call your local Western Union Representative

velope, and delivered by the local letter carrier on the next business day.

Mailgrams are transmitted into the Mailgram network in several different ways. Members of the general public may telephone their messages into one of Western Union's central telephone bureaus by way of a toll free 800 number. The receiving operator types the caller's dictated message into a CRT display and checks for errors before sending the message into Western Union's Infomaster computer system. Infomaster then routes the Mailgram by the zip code of the destination address to the nearest post office sectional center for dispatch to the local delivery post office.

Subscribers to Western Union's teleprinter services, TWX and Telex, can enter their Mailgrams directly into Infomaster by dialing 6161 from Telex or 910-420-1212 from TWX. When Mailgrams are transmitted from Telex or TWX, the use of paper-tape graphics (teleprinter graphics) makes a very nice message for birthday or Christmas greetings. Figures 1 and 2 show the proper formats for Mailgrams sent from TWX and Telex. As most communications people are aware, Telex uses the old five-level Baudot code at about sixty words per minute, while the TWX network uses

If Acoustic ASCII, You Can Squeak Like a TWX Machine

The TWX (TeletypeWriter eXchange) Network used to be owned by AT&T and associated independent telephone companies until 1973 when it was bought by the Western Union Telegraph Co. Because of the past history of the TWX network, it is still hooked up to the telephone exchanges in many smaller communities across the nation. In Paterson New Jersey, for instance, the number is 201-279-XXXX where XXXX are the last four digits of the TWX number. In the area of Paterson we find the Western Union FYI News Service, an IBM System 7 computer which is constantly updated with the latest in news headlines from around the world via the services of United Press International, the Chicago Board of Trade for commodities, and the U.S. Weather Service, to name but a few of the service's contributors.

Access is accomplished by an ASCII computer terminal with acoustic coupler and 110-Baud even parity (or no parity). One dials 201-279-5956 on the telephone, puts the phone in the coupler, and waits for the answer-back WU FYI MAWA to appear on the page. Each and every TWX machine has an answerback which consists of an electromechanical wheel in the back of the machine encoded with a unique identifier for each machine. One quickly enters carriage return, line feed (CRLF) and the System 7 thinks you are a TWX machine. The machine should then type ENTER CATEGORY NAME. At this point, enter NEWS CATE and you will receive the latest news and a complete catalog of available news subjects (including ski reports in season). You can enter as many different category names on one line as you please, remembering that the machine reads only the first four characters of any given category name, and that a space is needed between each category mnemonic. (Example: NEWS FINA MARK WEAT—carriage return—will give the reports for the news, financial, market, and weather categories.)

Of course you will be paying a substantial phone bill to Pa Bell at the end of the month, but that's what the FYI News is all about, sort of. It's a "Dial-A-Joke" type service which is paid for by the line charges of Western Union TWX and Telex subscribers who have access to the system. There is no other cost for the system. In fact, if you're a real infomaniac, you can get your own TWX or Telex machine, and have these news services transmitted direct to your teleprinter collect from the System 7. You can TWX a Western Union representative to discuss this at 710-988-2251 (answerback: WU SALES UPSR). Oh yes, and the TWX number for FYI for you folks with the real thing out there is 710-988-5956. Happy hacking!

ROMtutorial ROMtutorial

ASCII: *A standard code used to represent letters and numbers in binary on-or-off form. Seven distinct binary units, or bits, are used, allowing 128 different combinations.*

CRT: *Cathode Ray Tube. A television-style display device.*

Modems: *Devices which convert computer data signals into audio signals which can be sent over telephones.*

Paper-tape graphics: *Punched paper tape has eight rows where holes can be punched. A little cleverness can cause a paper tape to show a recognizable pattern, like letters or pictures.*

Five-level Baudot code: *An information transmission code used for teletype transmission. Each character is defined by a sequence of five on-or-off bits. Therefore only thirty-two distinct characters are possible.*

Acoustic coupler: *A means of connecting a modem to a telephone through the handset, so that no electrical connection is needed. A sort of mechanical ear and mouth.*

Mailgram formats for Telex

Figure 2.

1. Prepare your tape using the appropriate format.
2. Dial 6161. The computer will identify itself, activate your answer-back, and give a connection number.

```
WU ISCS
ALERCO CGO
004322A061 1420 EST
```

3. Transmit your tape. Stop tape reader following NNNN and wait about 9 seconds for a complete acknowledgment from the computer.

```
ACCEPTED
00001
1-PC
```

EXAMPLE OF A SINGLE MAILGRAM

```
ZCZC 001 CHICAGO ILL MAR 1
ZIP 07430
GEORGE SMITH PURCHASING
J. JONES CO.
   225 FRANKLIN RD
   RAMSEY NJER 07430
BT
TEXT TEXT TEXT TEXT TEXT
TEXT TEXT TEXT TEXT TEXT
   ALER CO
   427 SOUTH LASALLE ST
   CHICAGO ILL 60606
NNNN
```

EXAMPLE OF A MULTIPLE-ADDRESS (MA) MAILGRAM

(Same message to maximum of 50 addresses. Number in ascending order.)

```
ZCZC MA 002 BOSTON MASS MAR 1
ZIP 32015
J WITT CO
ATTN ENGINEERING DEPT
   136 SOUTH EVERGREEN AVE
   ORLANDO FLORIDA 32015
BT
TEXT TEXT TEXT TEXT TEXT
TEXT TEXT TEXT TEXT TEXT
   M BROWN CO
   130 STATE ST
   BOSTON MASS 01730
NNNN
ZCZC 003 BOSTON MASS MAR 1
ZIP 01730
J LAWLOR CO
PROGRAMMING SECTION
   637 CONGRESS ST
   BOSTON MASS 01730
BT
ZCZC 004 BOSTON MASS MAR 1
ZIP 49701
E COLE CO
   8001 SEVEN MILE DRIVE
   DETROIT MICHIGAN 49701
BT
NNNN
```

LEGEND

ZCZC	Start of message characters
ZIP AND NUMBER	The word Zip and Destination Zip Code Number must be on second line. (Destination Zip Code must also appear after state in address.)
BT	Beginning of text
MA	Multiple-Address indicator (Precede and follow with a space. Transmit in the first line only, as shown.)
NNNN	End of message characters. Transmit twice in a Multiple Address message: Once after the signature and again after the BT in last address.

FEATURES

☐ You can send up to 50 single address MAILGRAMS on one connection. (The messages must be numbered in ascending order.)

☐ You can transmit up to 2500 text words (15,000 characters) on a single connection.

☐ You can interrupt transmission for up to 9 seconds without being disconnected.

☐ You can send up to 4 lines of name-to and address between the zip code line and the BT.

☐ You can have up to 40 characters in each line of address.

☐ You can obtain an immediate acknowledgment by sending NNNNEND in place of NNNN after the last message on a single connection or after the BT in the last address of a multiple-address message.

REMEDIAL PROCEDURES

SITUATION An error is made while preparing a message tape.

REMEDY The LTRS key can be used to correct the tape. The computer is not affected by this nonprinting character.

SITUATION An error is observed while tape is being transmitted.

REMEDY If the NNNN has not been transmitted, you can stop the tape reader and wait 9 seconds for the computer to acknowledge and disconnect; a corrected message tape, including any rejected messages, can then be sent on a new connection.

SITUATION The circuit is disconnected before a complete acknowledgment (through 1-PC) is received.

REMEDY Resend your message(s).

SITUATION A Rejection Notice is received instead of an acceptance.

REMEDY The reason for the rejection will be given. Either correct the original tape or prepare a new tape and resend on a new connection.

ASSISTANCE

Contact the Computer Center Via Telex by dialing 4114

or call your local Western Union Representative

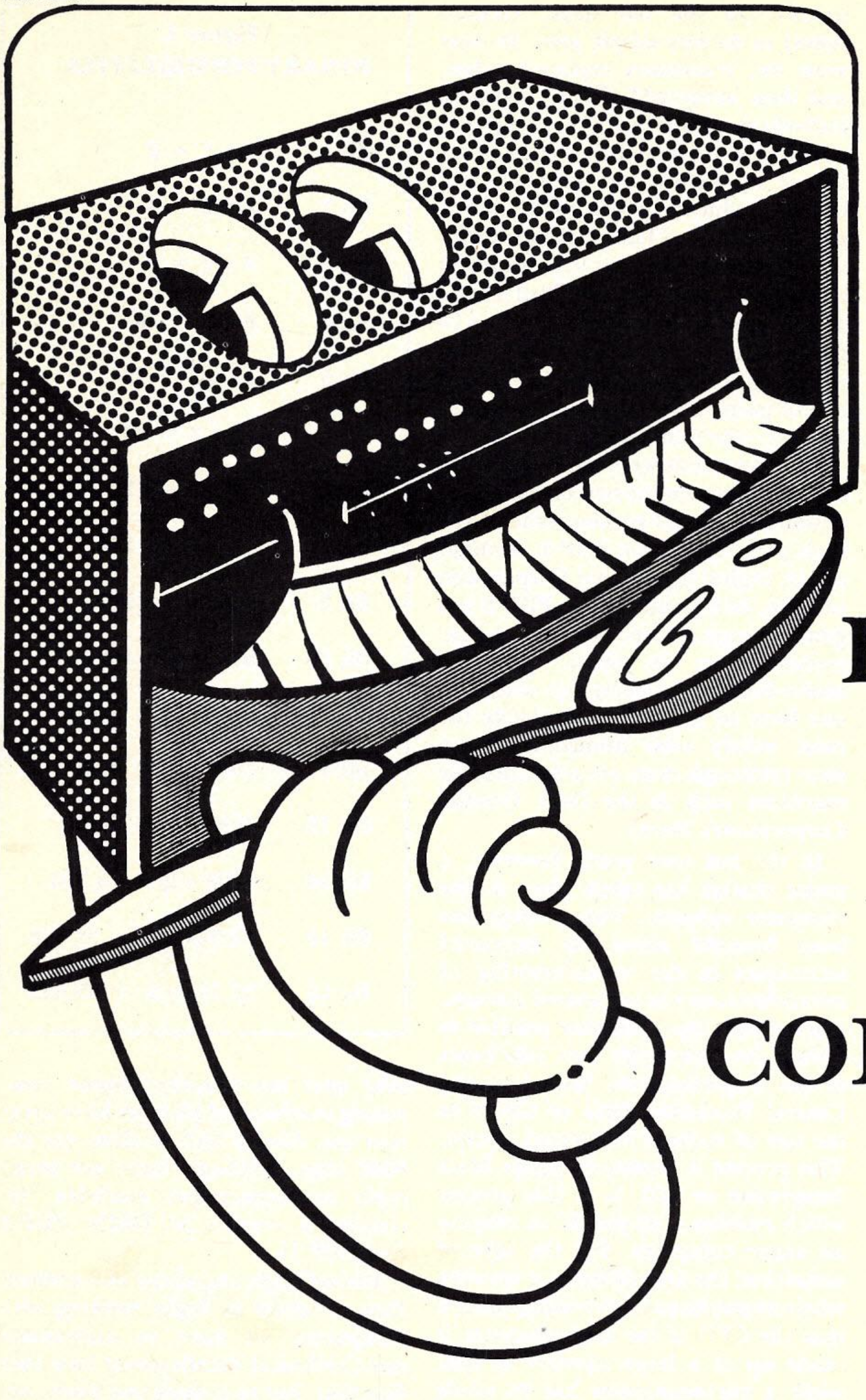
Among the largest users of tape-entered Mailgrams are banks and credit organizations sending dunning letters to their clients.

the eight-level ASCII code at 100 words per minute (110 Baud).

Mailgrams can also be entered into the Infomaster system from computer service bureaus having magnetic tape of the usual industry standards. These tapes must follow a special format in order to be entered into the Infomaster network. In order to facilitate "fill-in-the-blank" form letters, these messages can even have "holes" where new text can be inserted into the message. Among the largest users of tape-entered Mailgrams are banks and credit organizations sending dunning letters to their clients. In their use, the addressee's account number and the amount of money due can be inserted into the holes of the text. Due to an upgrading of receiving terminals in post offices, new envelopes and formats, can now allow a service bureau to put the client's address in the return-address portion of the Mailgram double window envelope. This is not only beneficial to the client, who gets the delivering post office's notation if delivery isn't made, but also it relieves the strain on the facilities at Western Union's Middletown Virginia Mailgram-processing site when Mailgrams cannot be delivered. What it boils down to is you send the message electronically and if the proper party isn't there to receive it, the message is returned by the post office's old horse and carriage.

People wishing to enter Mailgrams from their own computer terminals can do so by dialing the Western Union "Answer America" number at 800-325-6400 (in Missouri 800-342-6700) and asking for the "Fastel Operator." Unfortunately, they do not take paper tape at the other end, so sending graphics is not possible. ▼

Rex Ruden



THE CARE AND FEEDING OF YOUR HOME COMPUTER

by Bill Etra

Computers have leaped into the limelight in less than a decade. In 1960, when I was thirteen, my father bought me an analog computer kit from Edmund Scientific Co. It sat on a shelf in the basement for almost two years before I got around to assembling it. Not that I wasn't interested in science. On the contrary, all my friends and I were fascinated by an entirely different field of the subject. The real excitement at that time did not lie in computer technology, which was extremely limited, but in nuclear physics. It was my dream to own a Geiger counter, and enter the realm of the Atomic Age. In those days we were told that when we grew up, we would all be traveling around in atomic planes and trains and enjoying breakfast courtesy of our atomic toasters. Well, now I'm thirty, and I don't own an atomic toaster. I do, however, have three computers now, the smallest of which would have rivaled the largest, most expensive computer available at that time.

All of this just goes to show that predicting the future is, at its best, a risky business. You can never be sure that someone next door or twelve thousand miles away isn't having a revelation that will change the way the world works.

Computers started out as big bulky machines which needed lots of electronics (in the old days, vacuum tubes) to do very simple jobs. As time went by, transistors replaced tubes, and then integrated circuits replaced individual transistors. An integrated circuit may be viewed as a large number of transistors and support electronics, reduced in size to fit into a small package. (The package wasn't always small. The first transistorized PDP-8 system would have filled a metal rack approximately 6 feet tall by 19 inches wide by 24 inches deep.) With the advent of this reduction in size and cost of parts, a new breed of computer evolved—the minicomputer.

The first minis were built with transistors and cost in the tens of thousands of dollars for total systems. One of the most popular was the PDP-8, brought out by Digital Equipment Corporation in 1966. Still popular, the PDP-8 has gone through several changes, or generations, over the years. DEC also makes the PDP-11 computer which, in one form or another, is probably the most widely used minicomputer to date (although there are other notable machines such as the Data General Corporation's Nova).

In the last four years, however, a major change has taken place in the computer industry. This change has been brought about by improved techniques in the manufacturing of microelectronics or integrated circuits. During this time it became possible to reduce the entire logic unit (the heart of the minicomputer, known as the Central Processing Unit or CPU) to the size of a single integrated circuit. This process is known as Large Scale Integration or LSI. It is this process which enables a 40-pin IC to contain an entire computer. For the sake of definition, the only difference between minicomputers and microcomputers is that the CPU of the minicomputer is made up of a large number of ICs, while a microcomputer has its whole function block reduced to only one or two ICs by the use of LSI techniques.

Home computers were the logical outgrowth of these techniques. Intel Corporation made the first really interesting microprocessor, the 8008, which was followed by the 8080. The Intel 8080 is the microprocessor that sparked the home computer field. Les Solomon, Technical Editor of *Popular Electronics* magazine, published an article on how to build an Altair home computer in January 1975. Since that time over ten thousand home computing machines of all types have come into use. Almost half of these use the 8080 chip, although there are many other microprocessors available, including a version of DEC's PDP-8 and PDP-11.

Figure 1.
BINARY POSSIBILITIES

Bit 1	1 x 2 = 2
Bit 2	2 x 2 = 4
Bit 3	4 x 2 = 8
Bit 4	8 x 2 = 16
Bit 5	16 x 2 = 32
Bit 6	32 x 2 = 64
Bit 7	64 x 2 = 128
Bit 8	128 x 2 = 256
Bit 9	256 x 2 = 512
Bit 10	512 x 2 = 1024
Bit 11	1024 x 2 = 2048
Bit 12	2048 x 2 = 4096
Bit 13	4096 x 2 = 8192
Bit 14	8192 x 2 = 16,384
Bit 15	16,384 x 2 = 32,768
Bit 16	32,768 x 2 = 65,536

But we're getting ahead of ourselves. First, in order to begin working with computers, we have to understand some technical details about how they function. Just to understand them, not to memorize them.

The basic point about a digital computer is that it looks at information in a peculiar way. It looks only to see if something is there or not there. On or off? True or false? Suppose that we consider that "true" is indicated by the presence of some electronic signal. "False" will then be indicated simply by the absence of that signal.

Now think about number systems. We're used to the decimal system with ten digits. When you remember that 0

ROMtutorial ROMtutorial

Analog Computer: *A computer which gets its answers by combining and measuring analog values (like water pressures or degrees of rotation of a knob). Analog computers are simple but have built-in problems with accuracy.*

Integrated Circuit: *A transistor (not the radio) is a tiny speck of specially-processed silicon having three different layers. Integrated circuits contain hundreds or thousands of transistors formed in the same block of silicon, along with the necessary interconnections. The block is still quite small, so it's called a chip, and is often packaged in an inch-long block of plastic with metal connecting pins coming out. Often this package itself is called the chip.*

Central Processing Unit: *The "thinking" portion of a computer. It decides where to move information, what to do to it when it's there, and where it should look for its next instructions.*

Large Scale Integration: *The technical process which can result in ten thousand transistors cooked into a chip of silicon a quarter-inch on a side.*

IC: *Integrated Circuit.*

Microcomputer: *a small computer using a microprocessor for its central processing unit. A microprocessor is a CPU built using large scale integration.*

Minicomputer: *a table-top size computer, usually somewhat faster than a microcomputer and always more expensive.*

CONVERSION TABLE

Decimal 10	Binary 2	Octal 8 (or Q)	Hexadecimal 16 (or H)
0	00000000	000	00
1	00000001	001	01
2	00000010	002	02
3	00000011	003	03
4	00000100	004	04
5	00000101	005	05
6	00000110	006	06
7	00000111	007	07
8	00001000	010	08
9	00001001	011	09
10	00001010	012	0A
11	00001011	013	0B
12	00001100	014	0C
13	00001101	015	0D
14	00001110	016	0E
15	00001111	017	0F
16	00010000	020	10

is one of them, there really are ten: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, so we have a base ten system. If we have only two digits (1 and 0) in our number system, we have a base two, or binary system.

Each position at which the computer looks for a binary digit (1 for "true",' 0 for "false") is called a *bit*. Eight bits are almost always called a *byte*. A byte may or may not be a computer *word*. The number of bits in a computer word is the number of bits that make up the data path of the machine and may vary from machine to machine. The 8080, for example, handles eight bits or one byte, while the PDP-8 has a twelve-bit word. The PDP-11 can handle information in sixteen bits (two bytes) or eight bits (one byte)—so it has a sixteen-bit word. Larger computers commonly have word lengths in excess of sixty-four bits.

It looks only to see if something is there or not there. On or off? True or false?

What the word length of a computer means can be better understood if we look at the escalation of the powers of 2. If we have one bit, we have two possibilities (1 or 0). Two bits gives us 2x2, or 4 possibilities. Three bits gives us 2x2x2, or 8 possibilities, and eight bits gives us 2x2x2x2x2x2x2x2, or 256 possibilities (the multiplication is done for you in Figure 1). So, while an eight-bit word gives us a maximum of 256 possibilities, doubling it to a sixteen-bit word gives us 65,536 possibilities. Figure out the possibilities for the sixty-four-bit word of a large computer—it's staggering.

Since the arrangement of ones and zeros in a particular location in the computer may have to be studied from time to time, this can present a problem in dealing with a relatively long string of ones and zeros, usually at least eight bits. Besides, binary numbers like 11010011 are not easy for most people to decipher, and the highest eight-bit word (11111111) yields 255 or 256 as the highest decimal conversion (depending on whether you count from 0 to 255 or 1 to 256).

One way of handling binary numbers is to convert them to another

ROMtutorial ROMtutorial

Microprocessor: *The "thinking" section of a computer is called the central processing unit (CPU) or just the processor. If it's so small that you need a microscope to examine it, it's called a microprocessor.*

Chip: *Integrated circuits are literally cooked into wafers of silicon three or four inches in diameter. Hundreds of IC circuits are repeated on a wafer. Later, each wafer is broken up into chips each containing one integrated circuit. Often the IC is called a chip after the actual chip is embedded in a plastic body.*

Bit: *The simplest unit of information. It can be on or off. Electrical circuits are well-suited to dealing in bits, since it's no problem (usually) to tell the difference between a high and a low voltage.*

Byte: *A piece of information consisting of eight bits. It has 256 possible values and is usually used to indicate a typewriter character.*

number base. Unfortunately, the commonly used decimal number system (base ten) also does not fit well into our scheme of eight bits to the byte, since it has two more digits than the eight required.

So, we must find another number system. Both the base eight (octal) and the base sixteen (hexadecimal) are useful for converting binary numbers into a more readable form. (See the Conversion Table.) Remember that conversion to octal or hexadecimal is used only to make things easier for the human operator. The computer is ignorant of all but the binary numbers.

Octal conversion of an eight-bit word is read by segmenting the word as follows: 11/111/111. Thus 11111111_2 converts to 377_8. Hexadecimal conversion of an eight-bit word divides it evenly in two parts, so $1111/1111_2$ converts to FF_{16}.

Try converting another, harder example yourself: 10110111_2 converts to octal $\_\_\_\_\__8$, hexadecimal $\_\_\_\_\__{16}$, or decimal $\_\_\_\_\__{10}$.*

Predicting the future is, at its best, a risky business.

You may notice in the Conversion Table that we never use the digit “8” in octal, nor do we get anywhere near “16” in hexadecimal, but stop at 007_8 and $0F_{16}$ respectively. This is because we use the digit “0” as the first digit in each system. So octal uses the eight digits 0, 1, 2, 3, 4, 5, 6, and 7. Hexadecimal runs out of digits and uses letters: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, and F. Indeed, although we don't normally think of it that way, our common decimal (base ten) system uses 0 as the first actual digit, 9 as the last. The labeling of bit positions in octal would normally be bit 0 through bit 7. Some companies may choose not to use 0, however, just to confuse us.

The nineteenth-century English mathematician, George Boole, developed the logic for dealing with true/false conditions. Since true/false logic matches the on/off composition of binary computation, it is essential to the understanding of computers. Called Boolean Algebra or the algebra of logic, it will be dealt with in the next issue of *ROM*. ▼

---

*267_8, 87_{16}, 183_{10}.

HEXADECIMAL MULTIPLICATION PUZZLE

(Fill in the empty spaces in the upper right-hand triangle.)

	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
1	1		3	4	5	6	7		9	A	B		D		F
2		4	6				E	10	12	14	16	18	1A	1C	
3				C	F		15	18		1E	21	24		2A	2D
4				10	14	18		20	24		2C	30	34		3C
5						1E		28		32	37		41	46	4B
6						24	2A		36	3C	42	48	4E	54	5A
7							31		3F	46		54	5B		
8								40	48		58	60		70	
9									51	5A	63		75	7E	87
A										64	6E	78	82		96
B											79	84		9A	A5
C												90			B4
D														B6	C3
E														C4	
F															E1

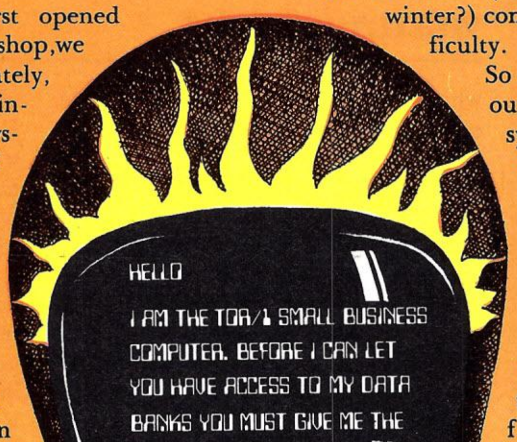
Remember the old multiplication tables used in school drills before the advent of the new math? Well, here's one for the single digits of the hexadecimal notation. The only problem is, our printer lost some of the numbers. Can you fill in the blanks? No fair turning to page 98 until you've given it a real try.

Altair and the Art of Motorcycle Shop Maintenance

by Gordon Morrison

In the running of a small retail business, one of the main problems is the multiplicity of jobs required from the proprietor. He is not only the salesman, but also the parts manager, stockboy, bookkeeper, and janitor. The most time-consuming and by far the most difficult job is that of parts manager. His task is to keep every item in stock and make sure it is priced correctly.

When we first opened our motorcycle shop, we realized, fortunately, the need for an inventory control system. Every one of the more than fifteen hundred items we stock was given a six-digit part number and a corresponding index card with all the information considered necessary for proper inventory control. Each inventory card contained part number, description, stock on hand, date last ordered, vendor's name, vendor's part number, wholesale price, and retail price. With this information, we tried to make intelligent *guesses* as to what, when, and how much to order. We were wrong much of the time, to say the least, because we had to depend on our memory to determine the popularity of an item. The cyclic nature of our business (motorcycles in the winter?) compounded the difficulty.



```
HELLO

I AM THE TOR/1 SMALL BUSINESS
COMPUTER. BEFORE I CAN LET
YOU HAVE ACCESS TO MY DATA
BANKS YOU MUST GIVE ME THE
CORRECT PASSWORD

PLEASE ENTER PASSWORD.
```

Lily Hou

So from the first day our inventory card system was implemented, we tried to find a faster and more precise way of doing it. We contacted a company with a professional inventory card system. The only difference between their system and ours was that they kept theirs in a horizontal bin while ours was stored in rotary files.

ROMtutorial ROMtutorial

4K Dynamic RAM memory board: *Random-Access Memory (in which the computer can write information as well as read it) using memory circuits which continually forget their information and must be reminded through the operation of special "refresh" circuitry. Such forgetful "dynamic" chips can be made very large, in this case 4096 bits. K stands for 1024, not 1000 as in metric measurement. Each S-100 type board holds eight 4K chips, and so can store 4K words eight bits at a time.*

Serial I/O board: *This board holds circuitry which converts computer information into a sequential stream of electrical signals which can be carried by a single wire. The reverse is also done by this board. I/O means input/output. Serial transmission is used when signals must travel a long distance over low-quality channels.*

Parallel I/O board: *Another input/output board which organizes the exchange of computer information as batches of electrical signals, each of which requires its own wire. These kinds of transfers can happen very fast but can't be sent very far.*

Floppy disk (and floppy diskette): *An information storage device which uses a "diskette" which looks like a 45 rpm disc but is coated with a magnetic surface like that used on a recording tape. The diskette is flexible, or "floppy." The disk drive rotates the diskette and can position a movable head which can magnetically write and read information on the diskette.*

73
Open
KERKER
ACCEL
SPECTRO
NGK
FLANDERS
master charge

Computer to the rescue.

Randy Leone

Inventory control with a computerized data base makes for supereffective management.

Computerized inventory systems didn't seem much better. The only system available to us at the time gave all the information we were looking for, but the record keeping was too cumbersome. Every item sold had to be tallied on the inventory printout, which in turn had to be torn off at the end of the month and mailed to the service center. That gave us only one update per month. It also cost us approximately $450 per month—three times our budget. Obviously, there was no low-cost solution to our problem.

HARDWARE

In January 1975 I bought one of MITS's first Altair 8800 computer kits, to satisfy my curiosity about how computers worked. As MITS added to their system's capabilities, it became obvious that they had the answer to our inventory problem. We bought an Altair 8800a with eight 4K dynamic RAM memory boards, an audio cassette interface, serial I/O board, parallel I/O board, floppy disk, PROM board, and we also bought a Southwest Technical Products TV typewriter. We ordered DISK BASIC but had to settle for 8K EXTENDED because DISK BASIC wasn't available. While waiting for DISK BASIC, we learned how to program by writing and modifying games. (I am now a Star Trek addict.)

All the MITS equipment was ordered assembled and it worked perfectly. The only problem we had was a blown IC in the serial I/O board. The local computer store quickly supplied a replacement, and we were back in business.

The TV typewriter proved to be too slow (110 baud), and the line width too restrictive (thirty-two characters) to be of use in a business application.

The computer keeps a tight rein on inventory, but it doesn't wait on customers yet.

Randy Leone

We plan to purchase a Lear Siegler ADM-3 video terminal as soon as possible. With twenty-four lines of eighty characters and a baud rate of up to 9600, it is ideal for a small business.

To increase throughput, we purchased a Processor Technology VDM-1 video display module. The VDM-1 went together easily and would have worked the first time if I hadn't installed an IC backwards. The VDM-1 has sixteen lines of sixty-four characters and a baud rate variable up to 9600. A BASIC program is provided to link the Altair BASIC interpreter with the VDM-1 machine language controller. However, the software wasn't able to link to 8K EXTENDED BASIC. A call to Processor Technology gave us the necessary patch and that link worked fine.

But the same problem occurred again when we tried to link to DISK BASIC. This time Processor Technology had no patch; evidently they became aware of the problem at the same time we did. The difficulty turned out to be not with the linking program but with version 3.4 DISK BASIC. Version 3.4 DISK BASIC's output routine contains an extra POP B machine language instruction that necessitated a major revision of the controller program. Now, however, the VDM-1 is operational and giving flawless performance.

SOFTWARE

Our present inventory control program creates a data base that can be used effectively in planning and controlling our physical inventory. With this program, we hope to minimize our stock on hand and reduce out-of-stock occurrences. Various options are available for better access to the data base.

The inventory program is divided into six separate programs, each of which runs independently of the others. This was necessary because of the limited amount of core memory available. We have 32K, of which 18K are used for the BASIC interpreter, leaving 14K for programs. The six programs are coordinated by a seventh program called OPTION.

OPTION

OPTION (see figure 1) controls access to all the other programs, pro-

ROMtutorial ROMtutorial

PROM board: *Programmable read-only memory. A board which holds previously-written PROM chips and allows the computer to read the information contained in them.*

DISK BASIC (and 8K EXTENDED BASIC): *High capability versions of the BASIC program which allow non-experts to write programs and be kept informed as they go about how they are doing.*

Baud: *A unit describing the speed of a serial I/O channel. One baud is one bit per second, originally used in telegraphy.*

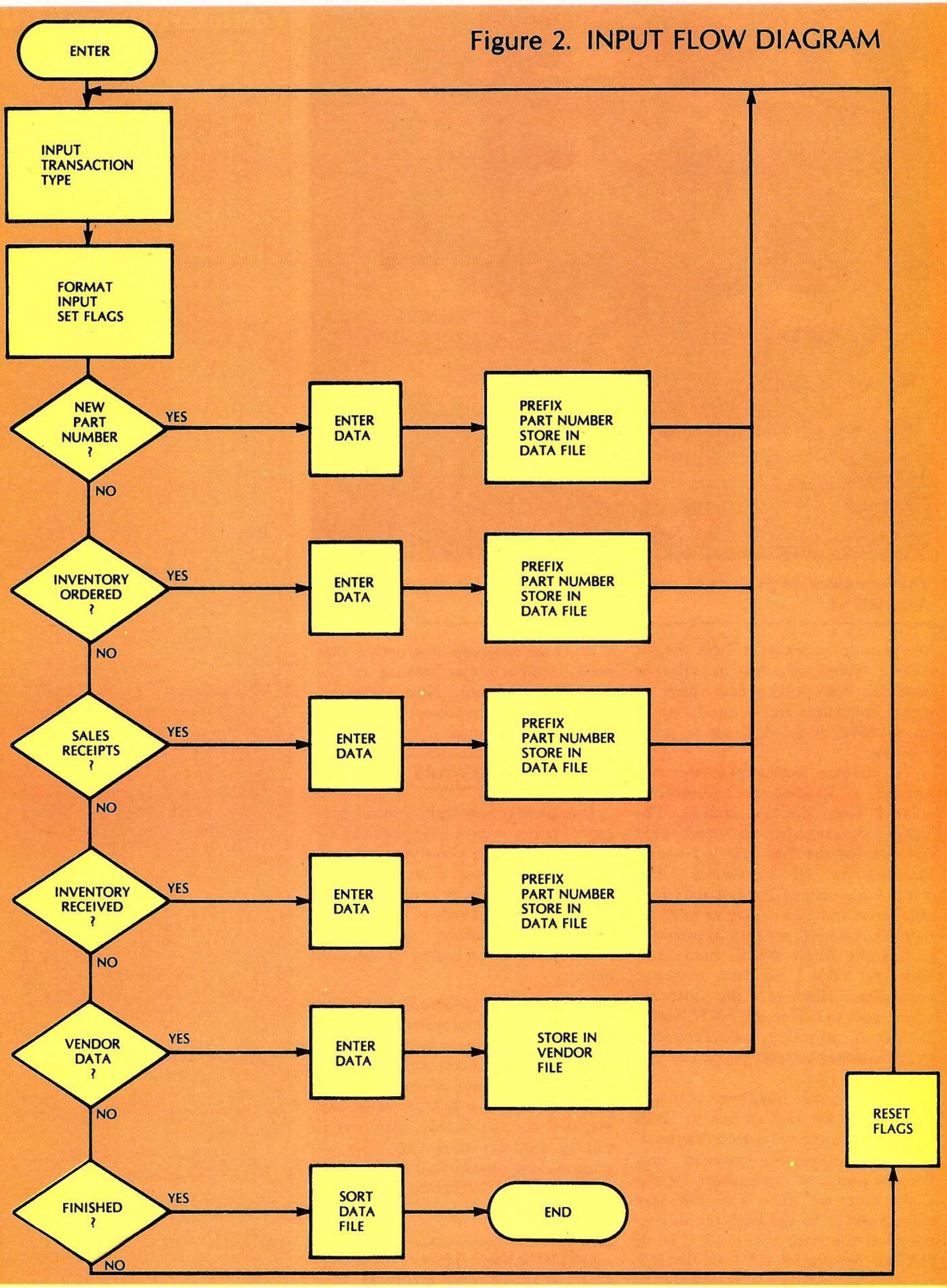
Baud rate: *The rate in bits per second at which a serial device like a teleprinter operates. Mechanical teleprinters operate from 35 to 300 baud: electronic display terminals go up to 19,200 baud.*

Throughput: *The rate at which information can get through a computer system as it is being processed.*

Core memory: *Memory used by the computer for "scratch pad" functions where speed is of the essence. In older computers this was done with networks of wires threaded through tiny magnetic rings, or cores. In recent years integrated circuits have replaced cores, but the name is still used, mostly by old-timers.*

POP B: *An instruction which, when issued to the 8080 microprocessor, causes it to read a number from the top of its "stack," a special area of memory. The next time this instruction is issued, the next number is read. The 8080 handles the bookkeeping automatically.*

Figure 2. INPUT FLOW DIAGRAM


ENTER
INPUT TRANSACTION TYPE
FORMAT INPUT SET FLAGS
NEW PART NUMBER ?
YES
NO
ENTER DATA
PREFIX PART NUMBER STORE IN DATA FILE
INVENTORY ORDERED ?
YES
NO
ENTER DATA
PREFIX PART NUMBER STORE IN DATA FILE
SALES RECEIPTS ?
YES
NO
ENTER DATA
PREFIX PART NUMBER STORE IN DATA FILE
INVENTORY RECEIVED ?
YES
NO
ENTER DATA
PREFIX PART NUMBER STORE IN DATA FILE
VENDOR DATA ?
YES
NO
ENTER DATA
STORE IN VENDOR FILE
FINISHED ?
YES
NO
SORT DATA FILE
END
RESET FLAGS

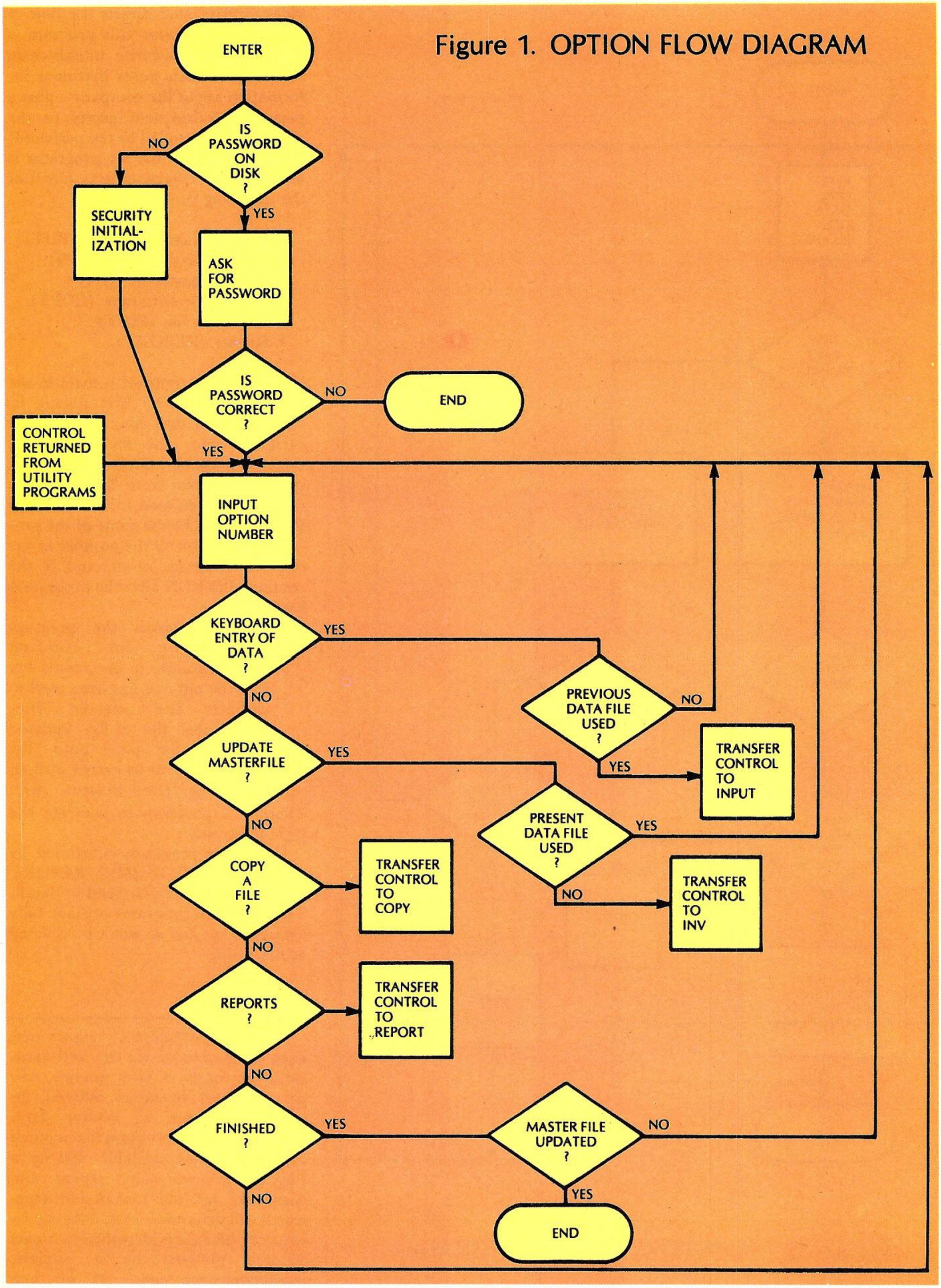


Figure 1. OPTION FLOW DIAGRAM

ENTER
IS PASSWORD ON DISK ?
NO
YES
SECURITY INITIAL- IZATION
ASK FOR PASSWORD
IS PASSWORD CORRECT ?
NO
END
YES
CONTROL RETURNED FROM UTILITY PROGRAMS
INPUT OPTION NUMBER
KEYBOARD ENTRY OF DATA ?
YES
NO
PREVIOUS DATA FILE USED ?
NO
YES
TRANSFER CONTROL TO INPUT
UPDATE MASTERFILE ?
YES
NO
PRESENT DATA FILE USED ?
YES
NO
TRANSFER CONTROL TO INV
COPY A FILE ?
TRANSFER CONTROL TO COPY
NO
REPORTS ?
TRANSFER CONTROL TO REPORT
NO
FINISHED ?
YES
MASTER FILE UPDATED ?
NO
YES
END
NO

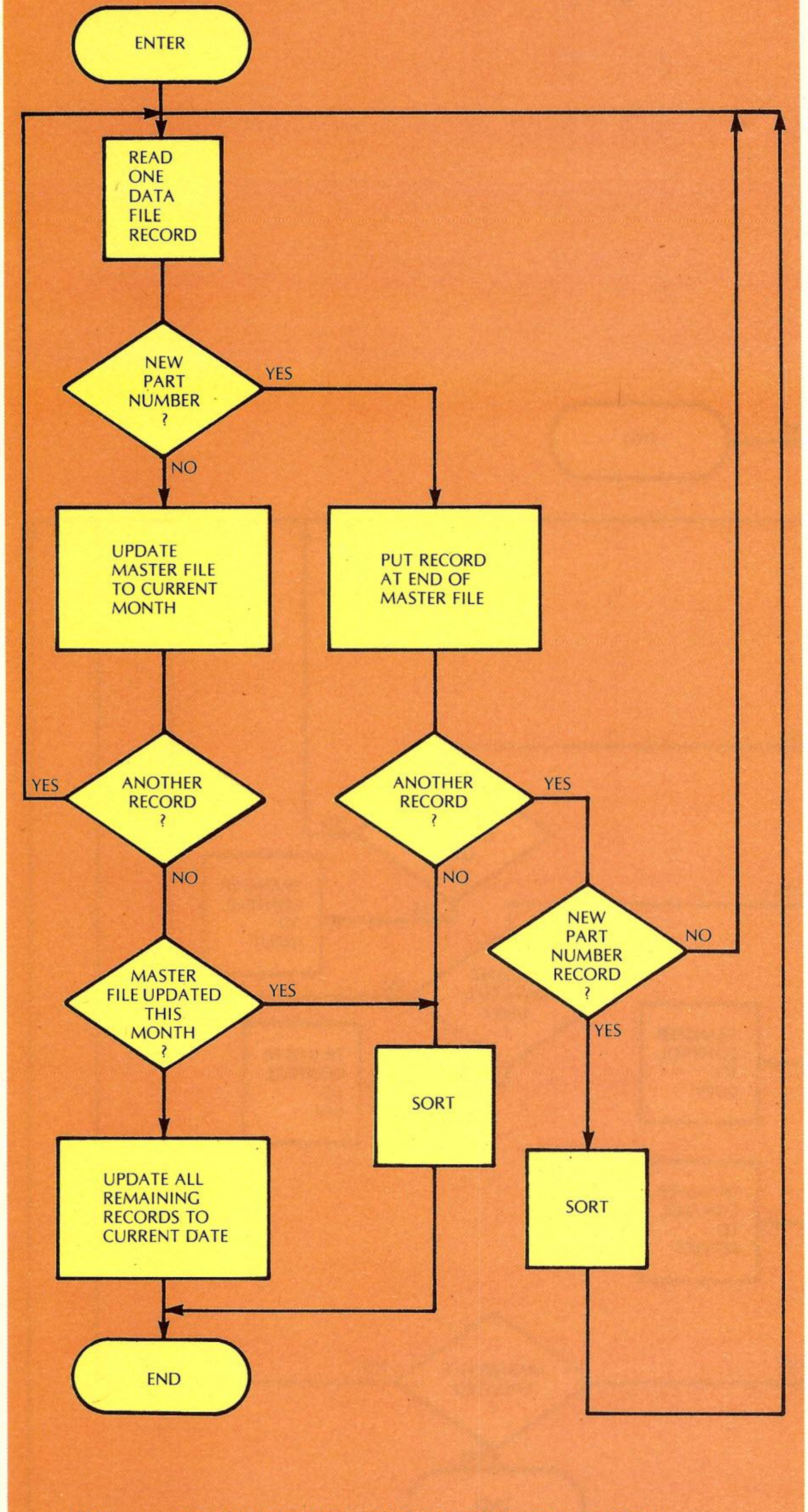

ENTER
READ ONE DATA FILE RECORD
NEW PART NUMBER ?
YES
NO
UPDATE MASTER FILE TO CURRENT MONTH
PUT RECORD AT END OF MASTER FILE
ANOTHER RECORD ?
YES
NO
ANOTHER RECORD ?
YES
NO
NEW PART NUMBER RECORD ?
NO
YES
MASTER FILE UPDATED THIS MONTH ?
YES
SORT
SORT
UPDATE ALL REMAINING RECORDS TO CURRENT DATE
END

Figure 3. INVENTORY FLOW DIAGRAM

vides security, and directs the flow of logic. The first time this program is run, there is a security initialization subroutine which stores pertinent information about the company—plus a password. Subsequent access to the program is controlled by the password.

Once access to the six programs is achieved, the computer asks which of the following you want to do:

- Keyboard-enter data (INPUT)
- Tape-enter data (TAPEIN)
- Update master file (INV)
- Copy a file onto tape (COPY)
- Change a file (EDIT)
- Report (REPORT)

OPTION then transfers control to the desired program by first storing its variables in a disk file, clearing the variable table, and then using the direct command LOAD to load and run the program from the disk. The command might read LOAD INV, O, R (INV would be the name of the program on the disk, O the number of the disk the program is on, and R the command to RUN after the program is loaded).

OPTION controls the program logic flow by not allowing
- —a new data file to be created before the old one has been used to update the master file.
- —the master file to be updated twice by the same data file.
- —the program to be exited without updating the master file.

There is a provision to override the logic if necessary.

Of the six programs controlled by OPTION, INPUT, INV, REPORT and COPY will be described in detail. The other two programs are not fully debugged yet and so won't be covered at this point.

INPUT

INPUT (see figure 2) allows new data to be entered via the keyboard. Data can consist of sales receipts, new part numbers, inventory ordered, inventory received, or vendor data. When called, the program lists a menu of input options available, sets up a flag so the menu won't repeat, and then asks for the transaction type, which will determine what data can be entered. All data is identified by a part number prefixed by a numeric transaction-type code: 01 for new numbers, 02 for inventory ordered, 03 for sales receipts, and 04 for inventory received.

After each new piece of data is entered, the program stores it in the file. Different transaction codes can be mixed in the same data file, except for vendor data, which is put into a separate file. When all the data has been entered, it is sorted according to the prefixed part numbers. This brings all new-part-number data to the beginning of the data file. Finally, program control is returned to OPTION.

INV

INV (see figure 3) uses the INPUT data file to update the master file, which contains all the information known about any item. (The Main File Variable Table lists the information stored in the master file.)

A total of 256 bytes is needed to store the information on one item. Out of 2048 128-byte records on the disk, 1500 are used for the master file, for a total of 750 items. Of the approximately 70K bytes remaining on the disk, 25K are used for program storage and 45K for the data file. Each additional disk drive will hold 1000 items.

MAIN FILE VARIABLE TABLE

PN	Part number
CU	Date record was last updated
WP	Wholesale price
RP	Retail price
SP	Minimum stocking point
RS	Restocking point
RQ	Reorder quantity
LT	Lead time (days)
ILY	Quantity sold last year
IYD	Quantity sold year to date
ITP	Quantity sold this period
I1P	Quantity sold in period one
I2P	Quantity sold in period two
....	....
I25P	Quantity sold in period twenty-five
YDS	Year-to-date sales
YGP	Year-to-date gross profit
STP	Sales this period
TGP	Gross profit this period
SOH	Stock on hand
SBO	Stock on back order
QO	Stock on order
DLO	Date last ordered
SLY	Sales last year
VN	Vendor number
VPN	Vendor part number
VWP	Vendor wholesale price
GPL	Gross profit last year
EDD	Expected delivery date
QTR	Quantity received
PO	Purchase order number
FLE	Fiscal year end
LTV	Lead time variable
RC	Reorder calculation type
OP	Order period
PS	Package size
E$	Part description
SL	Bin location
WL	Store number
SCO	Ordering costs
ICV	Inventory carrying costs
J5	Date item entered system

INV reads one new-data-file record at a time. If the first records consist of new part numbers, INV branches to a special subroutine that merges the new part numbers into the master file. As each new part number is read in, its prefix code is stripped off and the part number is placed at the end of the master file, from there to be sorted into its proper place in the file.

If there is more data, INV steps through the master file until a part-number match is made—or until the master file part number exceeds the data-file part number. When a match occurs, the master file is updated. If no match occurs, the extraneous part number is displayed with an error message and the program continues.

When the date of a data file indicates a new month, each master-file record encountered is historically updated. And after all the data-file records have been processed, INV checks to see if the master file has in fact been updated this month. If it hasn't been, the rest of the master file is updated at this point, and program control is returned to OPTION.

REPORT

A data base is of little value unless the information can be communicated to those who need it—in a form that can be readily understood. Hence the REPORT program. An unlimited number of REPORT programs could be written, but perhaps the most important is the order REPORT. The criterion for reordering an item is the restocking point, or RS, which has been calculated from average sales over a defined period and vendor lead time, plus a small safety factor.

If INV has found an item whose stock on hand (SOH) was below the restocking point, it set the reorder flag. When the order REPORT is run, the program reads each master file part number and reorder flag. Where the flag is set, the part number and vendor number are pulled off the disk and stored in a temporary file in core memory. Then, after every part number has been checked, the program asks what vendor number you want an order report for.

ROMtutorial ROMtutorial

Disk file: *A batch of information stored on a disk. Sometimes used to describe the disk itself, as if it were a filing cabinet.*

Byte: *A piece of information consisting of eight bits. It has 256 possible values and is usually used to indicate a typewriter character.*

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The order REPORT prints out one part number at a time along with the recommended reorder quantity or RQ. There are four ways to calculate the reorder quantity: as predefined by the operator, as based on average usage, on a seasonal basis, or in economic order quantity.

Predefined reorder quantities were entered when the part-number record was created for the first time.

Average-usage reorder quantity is based on the average number of items sold per month in all months for which data is available. This calculation is useful primarily for items that have constant demand throughout the year.

Seasonal reorder quantity is used when an item's sales fluctuate; it requires two years of sales history to work with any degree of accuracy. The program compares the last twelve months' sales, month by month, with sales for the previous twelve months and determines whether sales are increasing or decreasing. This data is used to project the number expected to be sold in the following month.

Economic order quantity is a calculation of the number of items to be ordered to maximize profit and minimize costs.

The order REPORT merely signals those items that should be reordered; it does not order them. (The order status can be changed only through the INPUT program.)

Along with the reorder quantity, enough information is given in an order REPORT for the operator to modify the computer's recommendations. The extra information given is: current stock on hand, stock on order, stock on back order, reorder point, wholesale cost, extension, gross sales last year, gross sales year-to-date, gross profit last year, and gross profit year-to-date.

Two more REPORTs are available: the maintenance REPORT and the review REPORT. The maintenance REPORT is a summary of all part numbers in use with their corresponding record numbers. The printout starts at record number one and lists twelve part numbers sequentially. A carriage return permits the display of twelve more part numbers, and so on until all records have been displayed. The maintenance REPORT can be used to find unused part numbers. It is also used in conjunction with the review REPORT, which prints out all known information in a given master-file record. Access to the review REPORT is by record number, therefore the maintenance program is used to find the record number from the part number.

COPY

The greatest catastrophe that could befall our inventory program would be losing its master file. The master file represents years of accumulated data that would be almost impossible to re-create. Periodically, therefore, a copy of the master file is made on another floppy diskette. All subsequent data files are also saved, so that if the original master file were to be destroyed, the master-file copy could be updated with the saved data files.

The COPY program is used to duplicate files. Since we have only one disk drive, copying files is a little tedious. COPY reads in ninety-eight 128-byte records, unloads the disk, asks for a new diskette, mounts it, writes out the ninety-eight records, unloads it, asks for the original disk, mounts it, and continues in the same fashion until all files are copied. Still, while data transfer is slow compared with maximum disk-transfer rates, it takes only a few minutes to transfer 750 records.

IMPROVEMENTS ON THE WAY

We are now trying to improve our inventory program by reducing its execution time. We feel it is possible to halve the main file updating time by reducing some redundant calculations and compressing the program by putting multiple statements on each line. We have found a few DISK BASIC statements we didn't know about that will greatly speed up execution of the PRINT-USING statements.

The next piece of equipment we plan to acquire is a printer. Presently, order reports are copied off the CRT screen. Hard copy would be much better. Also in the works is a remote data terminal to gather and display information at our store while the computer stays at home. I hope to have ready a progress report on how the pair are getting along together, plus some notes on the new terminal's machine language program, in the near future. ▼

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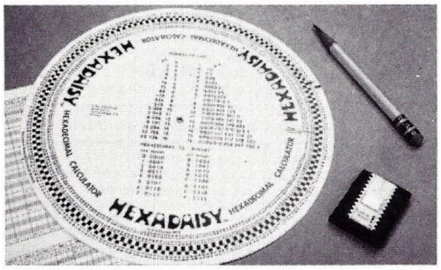


PERIODIC PERUSAL

With a personal computer you're going to get organized at last, right? Okay, but who's going to organize all that information about computers you need? Where was that article on light pens you read a couple of months ago? Or the piece on Dazzler displays? Not to mention the artificial intelligence which it looks as if it might need to keep track of all the new articles published?

Well, the *Periodical Guide for Computerists* puts it all together twice a year. The January-June 1977 Index is available now for $2.50 postpaid from E. Berg Publications, 1360 S.W. 199th Ct., Aloha, Oregon 97005.

A VOICE IN THE WILDERNESS

The VOTRAX voice synthesizer is at last coming in kit form for the budget minded. The actual price will be announced this month and is expected to be very competitive. The pre-assembled VOTRAX system already has wide application, particularly for the handicapped.

A specialized application of the VOTRAX is the Touch 'N' Talk system which consists of an electronic voice box operated from a 136-sensor board. The individual sensors respond to light pressure, and Touch 'N' Talk says whatever is written or illustrated on the activated sensor. The user can combine words and phrases to make sentences for storing in memory for on-demand recall.

VOTRAX produces quality electronically-synthesized speech with an unlimited vocabulary. Designed to convert digital computer output into electronically-synthesized speech, the process uses phonemes as building blocks for words and phrases. Inflection is then integrated to smooth the speech and make it intelligible.

No more shouting at a defenseless computer. It's going to shout right back.

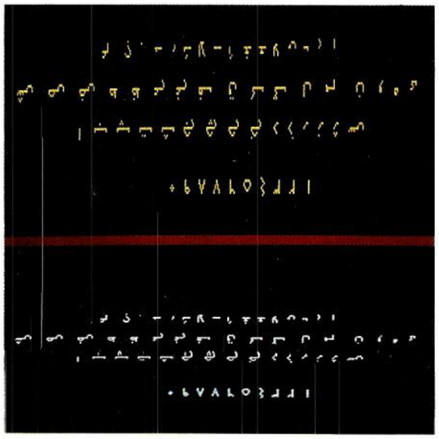
FARSI-OUT COMPUTERS

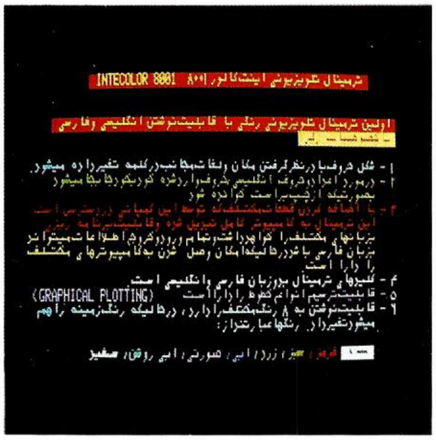
A unique keyboard operating system has been developed by Intelligent Systems Corp. which automatically changes the shapes of letters in a videographic display. This permits accurate display of languages such as Farsi and Arabic which use writing systems where the actual shape of the letters depends on their position in the word. The shape adjustment of the position-dependent letter is automatic with the operator entering letters from the keyboard without regard to form or capitalization.

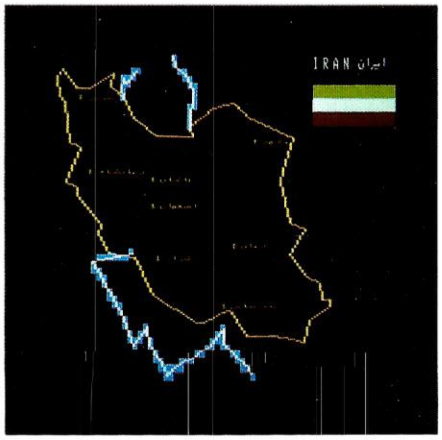
The display generator activated by such a dual language keyboard produces both English and Farsi alphanumerics in up to eight colors, using 30,720-point-addressing on a 160 x 192 grid for the graphics. Vector graphs or x and y bar graphs are both operable in incremental modes.

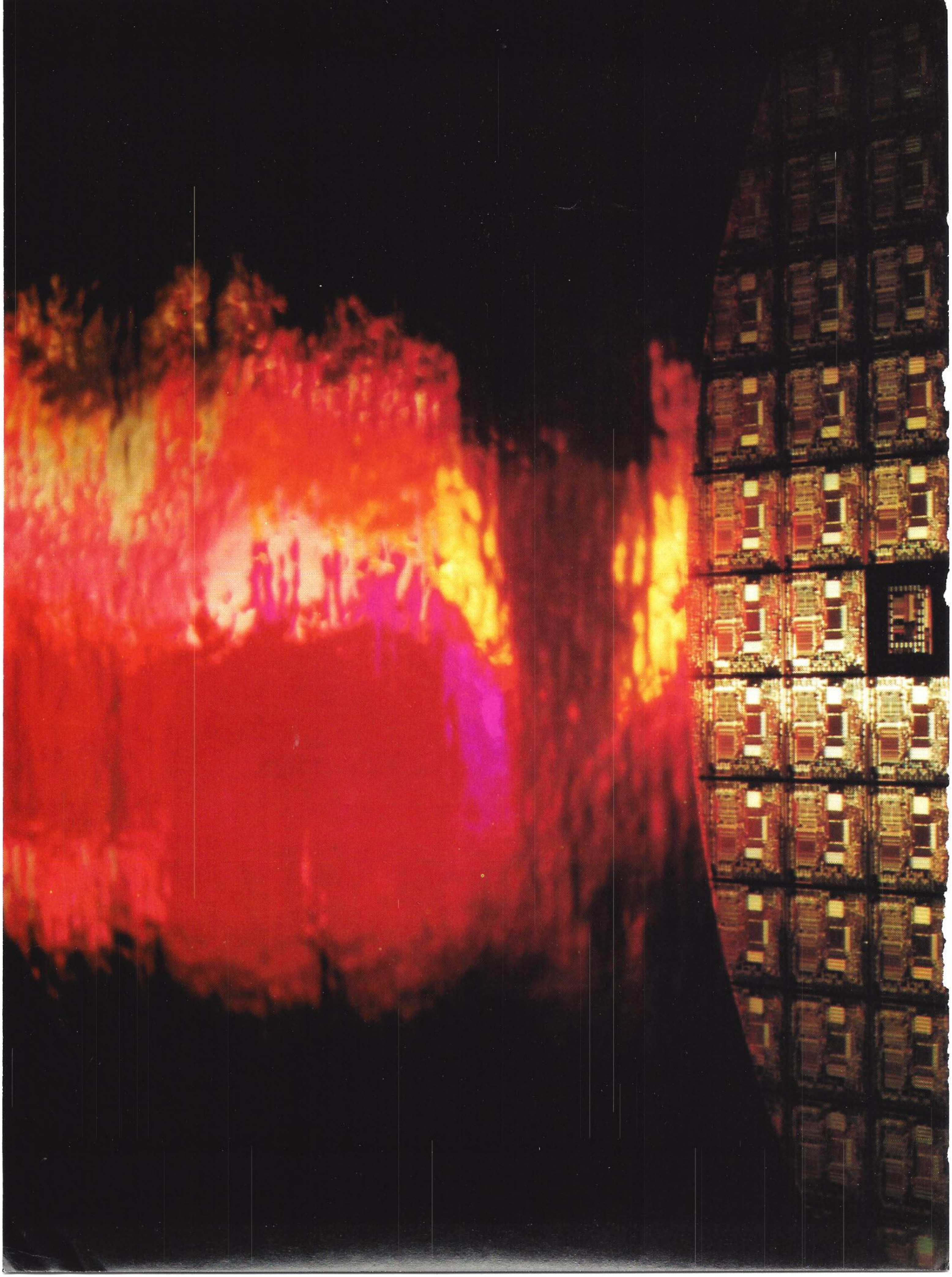
Software is in BASIC with peripherals including a light pen, single and dual floppy tape, and mini-disk drives.

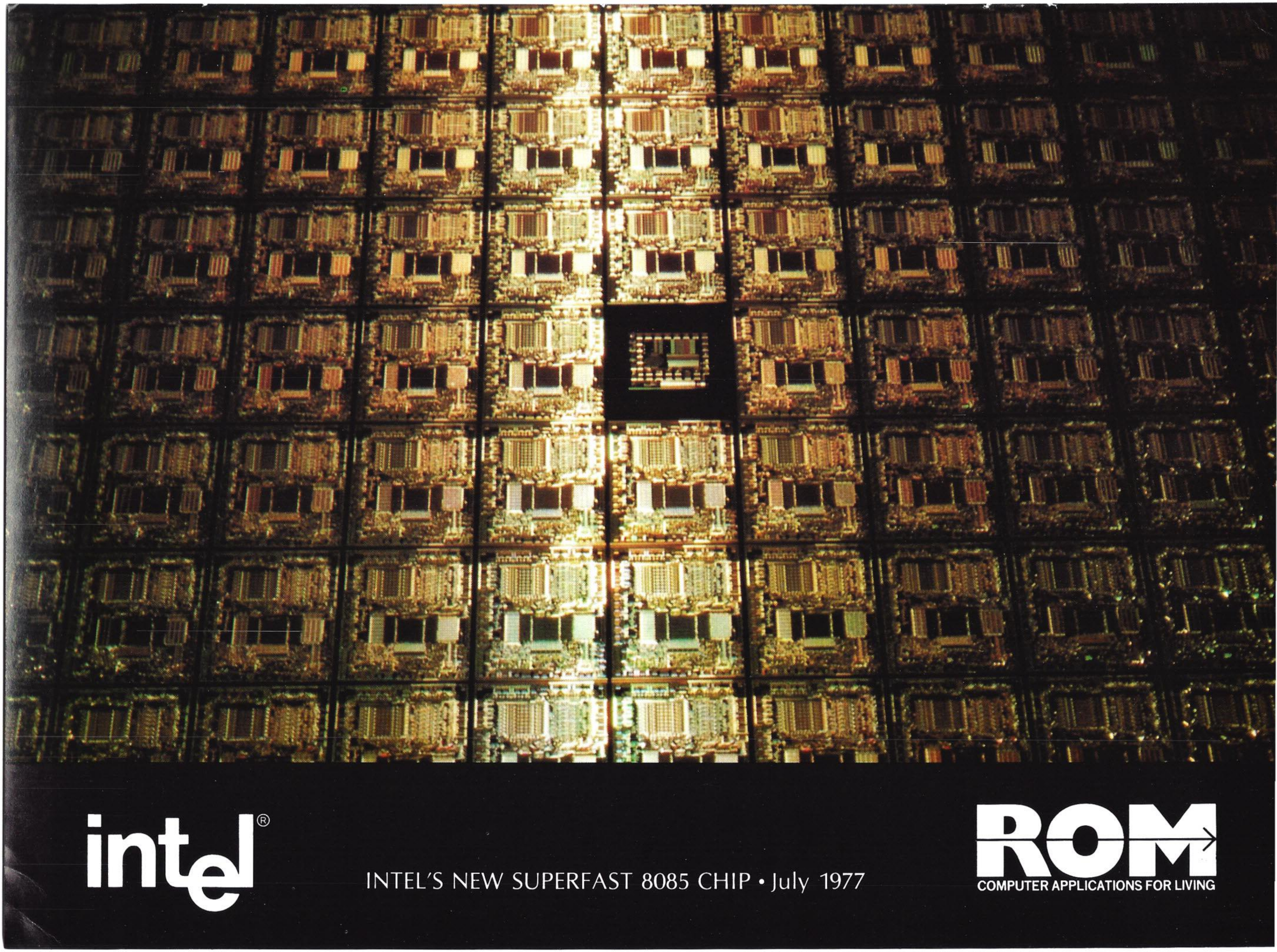
As yet there is no direct oil or gas well interface.











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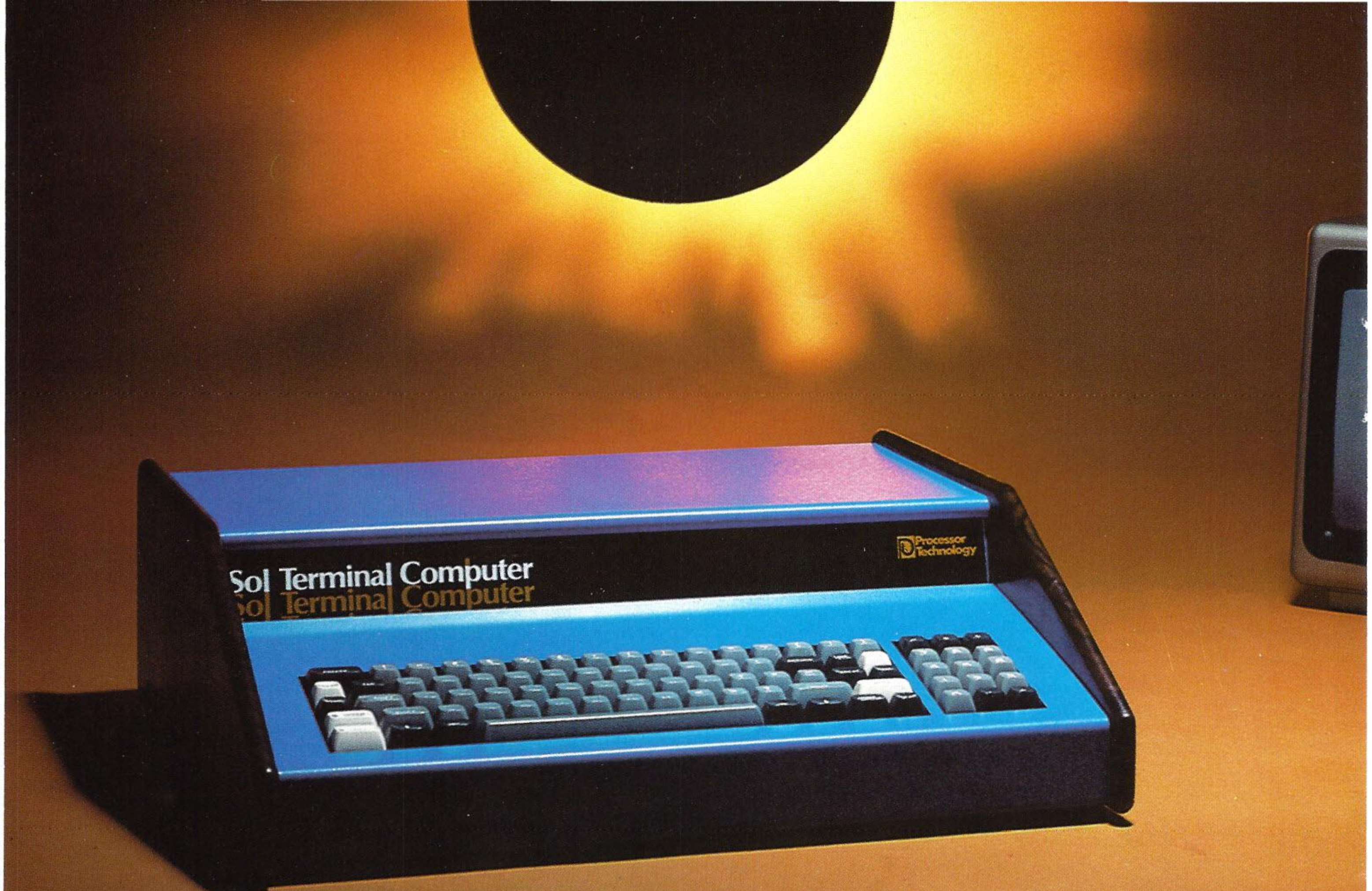

One Sol-20 equals three computers.

To do real work with any computer, big or small, it takes a complete system. That's one of the nice things about the Sol-20. It was built from the ground-up as the heart of three fixed price computer systems with all the peripheral gear and software included to get you up and on the air.

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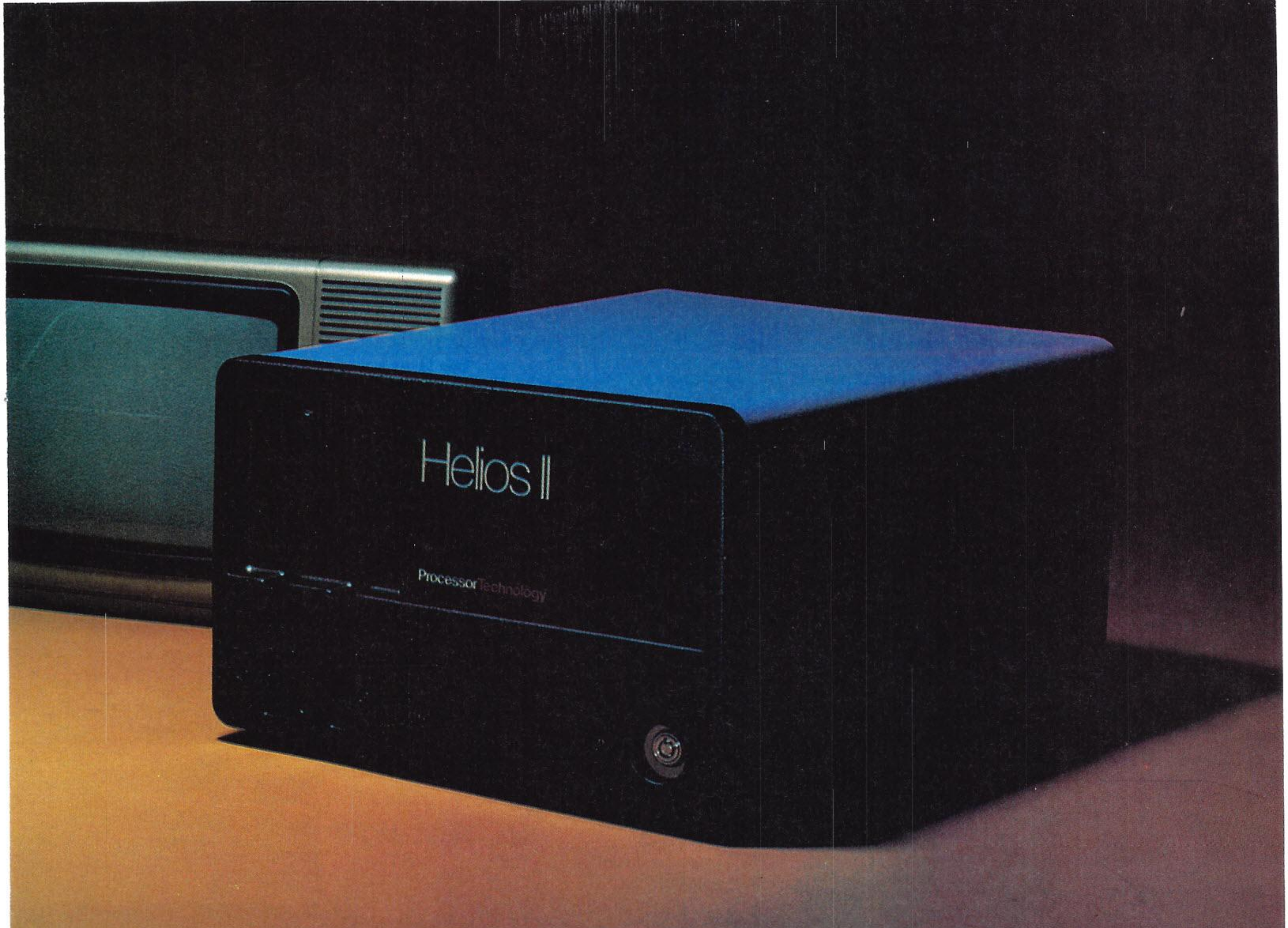
Sol System II has the same equipment plus a larger



capacity 16,384 word memory. It sells for $1883 in kit form; $2283 fully assembled.

For even more demanding tasks, Sol System III features Sol-20/SOLOS, a 32,768 word memory, the video monitor, Helios II Disk Memory System and DISK BASIC Diskette. Price, $4237 in kit form, $5037 fully assembled and tested.

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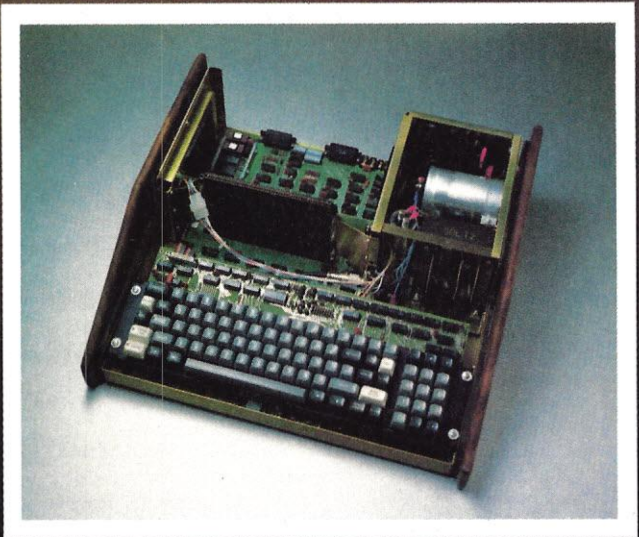

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The Small Computer Catalog for the rest of the real computer system story.

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(502) 456-5242

MICHIGAN

The Computer Store
of Ann Arbor
310 East Washington
Ann Arbor, MI 48104
(313) 995-7616

Computer Mart
or Royal Oak
1800 W. 14 Mile Rd.
Royal Oak, MI 48073
(313) 576-0900

Genral Computer Store
2011 Livernois
Troy, MI 48084
(313) 362-0022

NEW JERSEY

Hoboken Computer Works
No. 20 Hudson Place
Hoboken, NJ 07030
(201) 420-1644

The Computer Mart
of New Jersey
501 Route 27
Iselin, NJ 08830
(201) 283-0600

NEW YORK

The Computer Mart
of Long Island
2072 Front Street
East Meadow, L.I.,
NY 11554
(516) 794-0510

Synchro Sound
Enterprises
193-25 Jamaica Ave.
Hollis, NY 11423
(212) 359-1489

The Computer Shoppe
444 Middle Country Rd.
Middle Island, NY 11953
(516) 732-3086

Audio Design Electronics
487 Broadway, Ste. 512
New York, NY 10013
(212) 226-2038

The Computer Mart
of New York
118 Madison Ave.
New York, NY 10001
(212) 686-7923

The Computer Corner
200 Hamilton Ave.
White Plains, NY 10601
(914) 949-3282

OHIO

Cybershop
1451 S. Hamilton Rd.
Columbus, OH 43227
(614) 239-8081

OKLAHOMA

High Technology
1020 West Wilshire Blvd.
Oklahoma City, OK 73116
(405) 842-2021

OREGON

Byte Shop Computer Store
3482 S.W.
Cedar Hills Blvd.
Beaverton, OR 97005
(503) 644-2686

The Real Oregon
Computer Co.
205 West 10th Ave.
Eugene, OR 97401
(503) 484-1040

Byte Shop Computer Store
2033 S.W. 4th Ave.
Portland, OR 97201
(503) 223-3496

RHODE ISLAND

Computer Power, Inc.
M24 Airport Mall
1800 Post Rd.
Warwick, RI 02886
(401) 738-4477

SOUTH CAROLINA

Byte Shop
2018 Green Street
Columbia, SC 29205
(803) 771-7824

TENNESSEE

Microproducts & Systems
2307 E. Center St.
Kingsport, TN 37664
(615) 245-8081

TEXAS

Byte Shop
3211 Fondren
Houston, TX 77063
(713) 977-0664

Computertex
2300 Richmond Ave.
Houston, TX 77098
(713) 526-3456

Interactive Computers
7646½ Dashwood Rd.
Houston, TX 77036
(713) 772-5257

The Micro Store
634 So. Central
Expressway
Richardson, TX 75080
(214) 231-1096

VIRGINIA

The Computer Systems
Store
1984 Chain Bridge Rd.
McLean, VA 22101
(301) 460-3634

Media Reactions Inc.
11303 South Shore Dr.
Reston, VA 22090
(703) 471-9330

WASHINGTON

Byte Shop Computer Store
14701 N.E. 20th Ave.
Bellevue, WA 98007
(206) 746-0651

The Retail Computer Store
410 N.E. 72nd
Seattle, WA 98115
(206) 524-4101

WISCONSIN

The Milwaukee
Computer Store
6916 W. North Ave.
Milwaukee, WI 53213
(414) 259-9140

CANADA

Trintronics
160 Elgin St.
Place Bell Canada
Ottawa, Ontario K2P 2C4
(613) 236-7767

First Canadian Computer
Store, Ltd.
44 Eglinton Ave. West
Toronto, Ontario M4R 1A1
(416) 482-8080

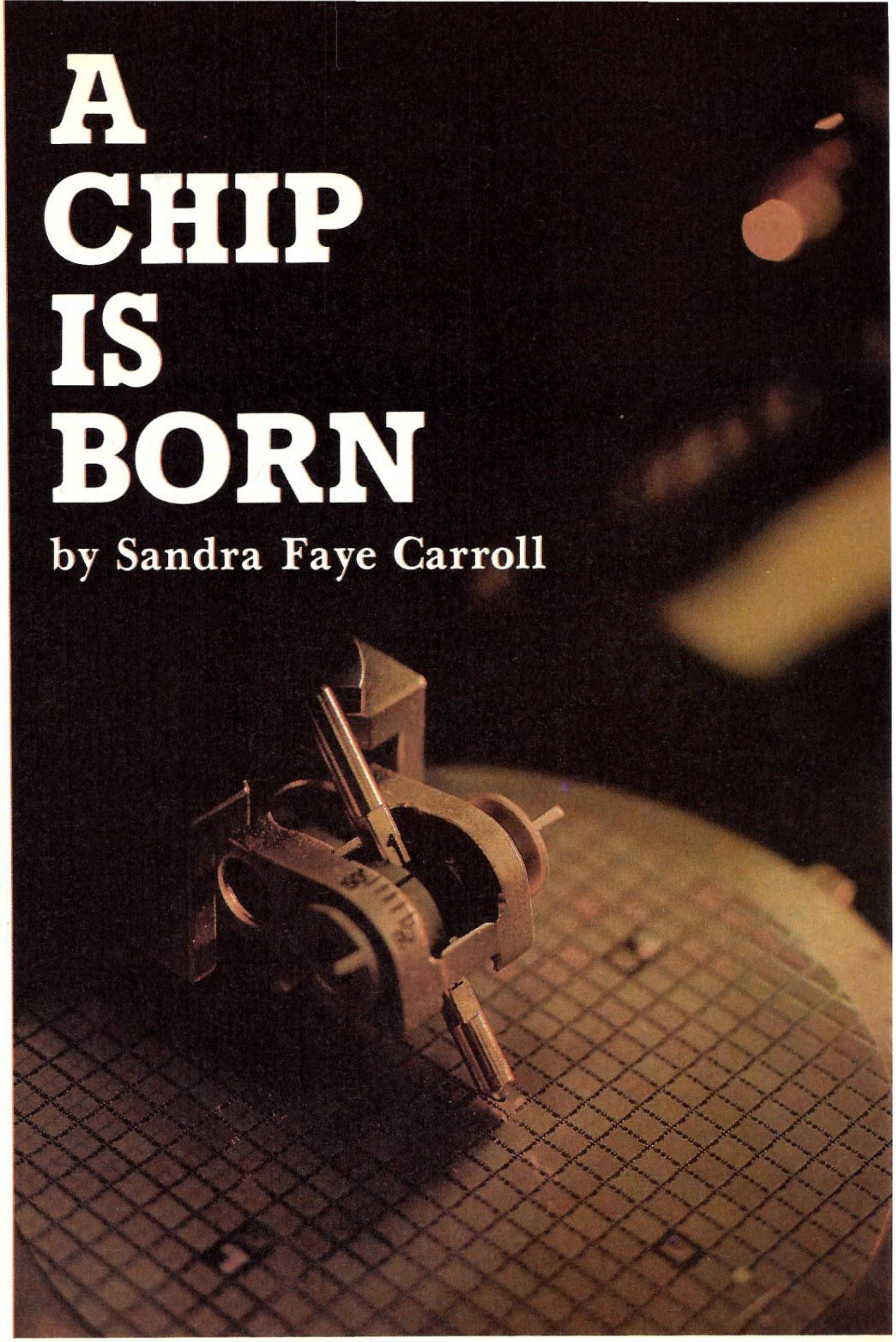
The Computer Place
186 Queen St. West
Toronto, Ontario M5V 1Z1
(416) 598-0262

Pacific Computer Store
4509-11 Rupert St.
Vancouver, B.C. V5R 2J4
(604) 438-3282

Processor
Technology
Corporation

A CHIP IS BORN

by Sandra Faye Carroll



This is the first step in Assembly, after all wafer fabrication is complete. Wafers are scribed, then broken apart to separate good circuits from those which do not function (determined at a prior test in an area called "Wafer Sort"). Scribing permits an even break around each circuit. The tool is a diamond-tipped cutter which functions like a glass cutter.

Intel

During the heart of the Depression, my cousin Malka decided to stop talking to my cousin Leah, who lived down the hall, because Leah didn't believe that the local watchmaker had really engraved the entire Lord's Prayer on the head of a pin. (Such feuds weren't uncommon in that family. Usually two or three quarrels of venerable age were being nursed along at any given time. Dinner conversation was spotty.) Even today, such feats of patience and precision don't quite seem possible. And yet, we all take for granted that the electronics industry can and routinely does engrave circuits with hundreds of transistors on a piece of material approximately ¼-inch on a side. The scale is so inconceivable that we just have chosen to accept it as a simple, mundane fact. But, in fact, the production of a computer chip is a miracle of ingenuity and elegance overlaid with more than a flush of futurism.

In 1968 Robert Noyce and Gordon Moore, former students of William Shockley and founders of Fairchild Semiconductor, broke away from the mother glacier, formed Intel, and produced the 1103 chip, a memory that could store 256 bits of information. Soon afterward they introduced the 8080, the first microcomputer on a chip, and revolutionized the computer industry. Last year they materialized a memory that can store 16K bits, still on a tiny piece of silicon about half the size of a child's little fingernail. Because they make it all look so easy, let's follow a hypothetical chip from birth through majority at the corporation's world headquarters in Santa Clara, California, a bit northwest of San Jose.

First of all, the chips don't grow up alone. They are born

The Masking Area in the wafer fab. The operator is at a "spinner." A light-sensitive chemical, photoresist, is dispensed onto each wafer; the wafer is then spun at high speeds to distribute the material evenly over the surface of the entire wafer (the patterned side). The yellow light does not affect the chemical.

Intel

and mature alongside 250 or 300 identical siblings on a wafer of silicon about three inches in diameter. Silicon, a semi-metal with some of the properties of carbon, is present in the earth in greater amounts (twenty-six percent greater) than any other element but oxygen. Its importance in the mineral world matches that of carbon in the organic world. As silicon dioxide, it is part of sand, flint, quartz, and opal, while as complex silicates of aluminum, iron, magnesium, and other metals, it participates in practically all rocks, clays, and soils.

Outside suppliers turn rough silicon compounds into thin iridescent teal blue disks. Once delivered to Intel's clean rooms, the wafers begin a merry-go-round ride of visits to stations along a route that always ends up at the beginning. They are batch-processed, going through all stages approximately ten times as the circuits are built up layer by layer. The clean rooms in the center of Intel's glass-walled Silicon Valley rectangle are scrupulously cleansed and filtered of dust and chemical pollutants by the laminar flow units so common everywhere in the electronics industry. The operators inside wear body suits, hoods over their hair, and mittens over their shoes, looking like characters from *The Andromeda Strain.* No one ever touches a wafer with her hands. ("This sort of repetitive, meticulous work is woman's work. Only a few men can stand it.") She uses either forceps or rubber gloves.

After cleaning, vacuuming, and dusting the wafers, the operator files them into polyethylene boats, each capable of holding twenty-five wafers, and sends them on to their first station—oxidation in furnaces which reach temperatures of 2200 degrees Fahrenheit. The heat in the furnaces, and some occasional steam injected into the ovens, grows a layer of silicon dioxide on all of the surfaces of each wafer, the way rust develops over a much longer period on a piece of iron exposed to the natural forces of air and dampness.

A miracle of ingenuity and elegance overlaid with more than a flush of futurism.

Then the wafers travel to the Masking Area, lit with yellow light that blocks the ultaviolet end of the spectrum. Metal carriers feed the wafers one at a time into spinners which look like heatless, futuristic ovens. The spinners dispense an even, thin coating of photochemical resist, a substance which turns the wafer into something akin to photographic-print paper so that it reacts only to ultraviolet light (hence the yellow overhead lights). The wafers come out of the spinners sticky, so they are baked quickly to dry the solvents out of the chemical without affecting their light-sensitive properties.

Next stop on the tour is Align and Expose, where four operators use four projection printers, machines that superficially resemble binocular microscopes. Using a forceps, the operator places a wafer on a printer's vacuum chuck, a holder with a diameter about the same as that of the wafer. She puffs the surface of the wafer clean with nitrogen (an inert gas), pushes a button, and the wafer disappears into the innards of the machine. Viewing the wafer through the binocular scope head, she aligns a glass plate, called a mask, over the wafer. Each mask is the pattern for one level of the circuit. It has been reduced from an original four-foot-by-five-foot drawing to a size small enough to fit 300 times on a three-inch disk. This first, bottommost layer must follow the grain running through the silicon so that the wafer later will break cleanly into the appropriate number of chips, all of the correct size and shape. When the mask is arranged on the wafer to within one-tenth of a micron's accuracy (one two-hundred-fiftieth of the thickness of a human hair), the operator pushes a button aiming a beam of high intensity ultraviolet light onto the wafer through the mask, exposing the non-masked parts of the wafer. The moment the light hits the uncovered parts of the resist, the chemical polymerizes, becoming hard and non-reactive. The unexposed lines on the wafer, the masked parts which will eventually become the circuit, remain relatively soft.

The wafers travel next to the Developers, where they soak for a carefully timed period in a solution which washes off the unexposed, soft, reactive parts of the photosensitive resist, exposing, in carefully patterned areas, bare oxide. At this stage other operators, among the most highly skilled in the system, eyeball each wafer under a microscope to make sure that the masks were aligned correctly on the wafers, and that the proper parts of the resist were removed. If some error shows up, the wafer is stripped and sent back to the beginning of the process.

All correct wafers now enjoy an acid bath at the Etching Station, in either hydrofluoric, hydrochloric, or sulfuric acid to eat away part of or all of the oxide in the channels which were made by developing away the unmasked, unpolymerized resist. Once channels are cut into the oxide, the polymerized photoresist is stripped off, and the wafer moves along to the Diffusion-Thin Films Area.

Here a wall of open doors, glowing orange-red at their gaping mouths, radiates temperatures in excess of 2200 degrees Fahrenheit. Each door shields an oven that enlarges to internal dimensions approximately five feet wide by eight feet deep. Inside the ovens, electrically positive and negative regions in the circuitry of each chip are created, where there were only channels before. Something has to be added to the silicon dioxide or to the bare silicon in order to make it a good conductor. Just what depends on whether the level of the circuit should be positive or negative. Gases such as nitrogen, oxygen, hydrogen, silane, phosphine (a nerve gas developed during World War I—direct contact kills a human being in five seconds flat), and arsene (which forms pure arsenic) combine with such liquids as hydrofluoric and sulfuric acids, solvents such as isopropanol and acetone, and the dopant agents which actually control the electrical characteristics of the chip.

The operators look like characters from *The Andromeda Strain.*

The wafers are loaded into highly heat resistant glass cradle-boats, also called sleds, and the sleds are loaded onto tubular glass "white elephants" (nobody could tell me what the name means). Slowly and automatically they feed into the oven along pole-like feeders which can take anywhere from one to sixty minutes to get the cradle all the way inside. If the wafers encountered these ultra-high temperatures in one rude shock, they would warp or shatter. (Once, a bee managed to outwit all of the air locks and laminar flow systems and flew toward one of the furnaces. As soon as it entered the mouth of the oven, it exploded, contaminating everything and causing a furnace shutdown for days while the area was thoroughly scrubbed.)

Which gases combine with which liquids is proprietary information, so, without committing ourselves to plus or minus, let us suppose that nitrogen gas is injected into the oven, combining at the ultra-high temperatures with an unnamed liquid dopant agent. The nitrogen gas carries the dopant all over the furnace, coating the walls of the oven, the wafers, and the glass cradle-boats they nestle in.

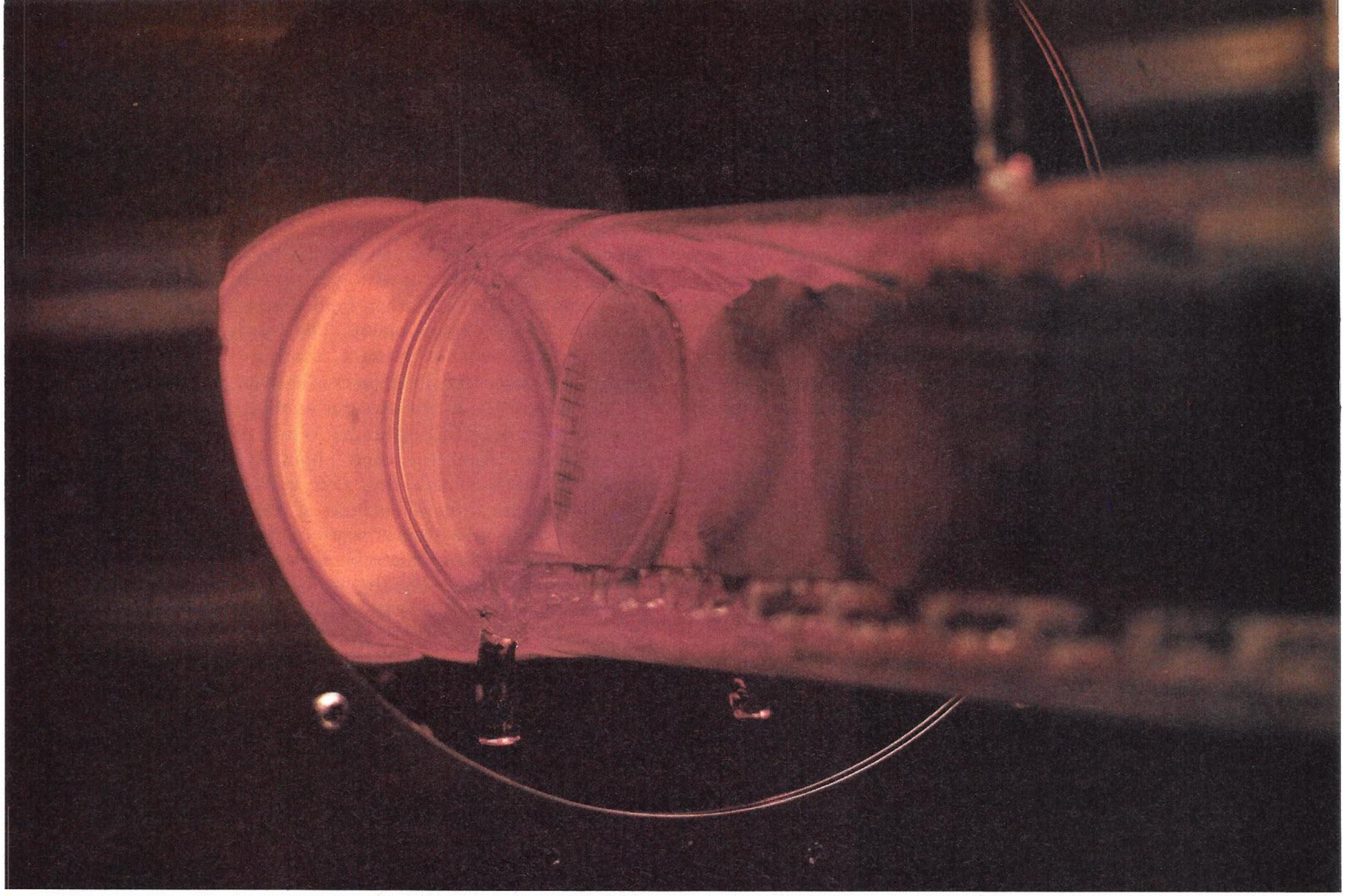
The wafers roast in the oven for as short a period as ten minutes or as long as ten hours. When their time is up, they withdraw from the oven about as slowly as they entered it. Once cooled, they take another acid bath to clean the dopant from all surfaces of the wafer. However, silicon is porous and absorbs some of the dopant into the bottom of the circuitry channel the way a concrete driveway holds an oil stain. The dopant lying under the surface of the silicon will tell the metal applied later whether to be positive or negative.

This completes one circuit of the fabrication area, an average trip of two days, three full eight-hour shifts per day. The itinerary begins again for the next layer of circuitry—photomasking, developing, etching, thin films, the works.

After perhaps ten trips round the fab area, the entire circuitry pattern has been laid down, but there is no metal on the chip to conduct the electricity in and out through the circuits. Now a process worthy of an Asimov science-fiction novel vaporizes aluminum and spreads it all over the face of the wafer. Inside a large bell jar, three planetaries hold a total of thirty wafers in an armored version of a three-armed octopus. Sealed inside the jar, the wafers wait as most of the air is pumped out of the chamber. (The air gets so thin that it heats up, so the bell jar needs its own continuous cooling system.) Underneath the planetaries sits a crucible of aluminum pellets. As the planetaries

An acid station. Note the protective clothing worn by the operator: apron, sleeves, face shield, rubber gloves. Acids and strong chemicals are used at various stages of the wafer-fabrication process to either help create the circuit patterns on the wafers or to clean unwanted material off the wafers.

Intel

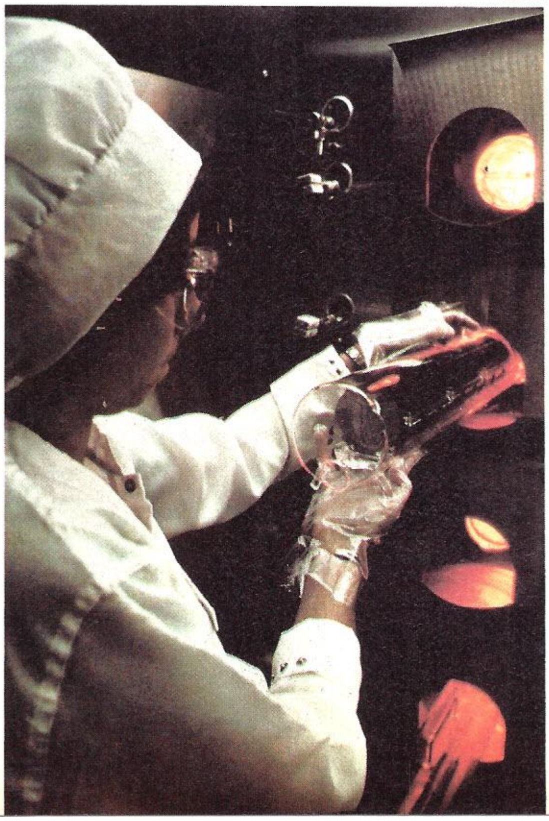


Intel

The mouth of a Diffusion furnace. Wafers are visible in quartzware sleds (specially made to withstand the temperatures which can be as high as 2200 degrees Fahrenheit).

Wafers placed in the furnace.

Intel

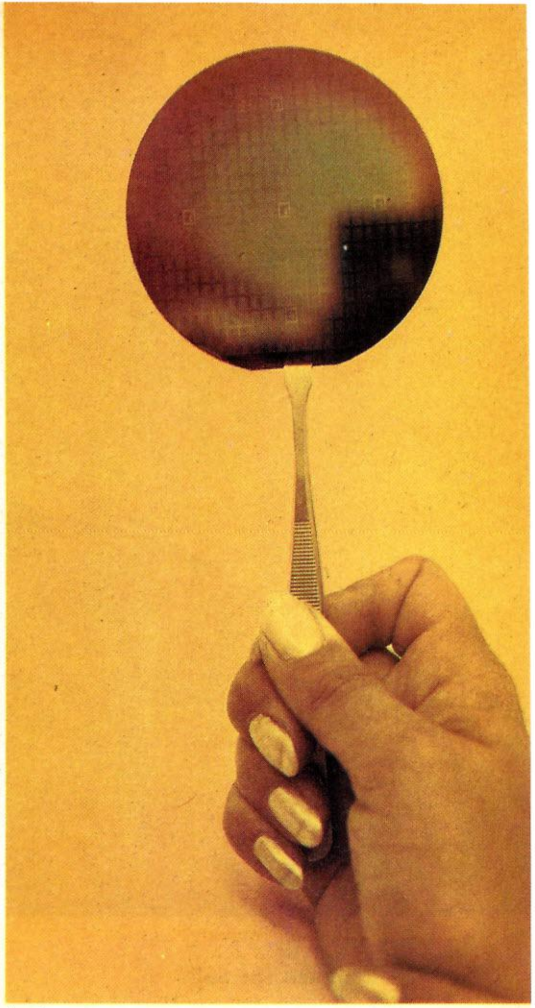


begin to spin, an operator aims an electron beam, an intense electric torch, at the aluminum pellets and they evaporate in the thin air, vaporizing and turning into a sort of aluminum steam, rising and coating everything in the jar the way water steam coats everything inside a Chinese steamer pot. During this entire process, the planetaries spin the wafers to keep the coating spread evenly over their surfaces. When the aluminum evaporation process is complete, the operator slowly lets the air back into the bell jar, removes the wafers, and sends them back to the yellow-lighted side of the room where they receive another layer of photoresist, another mask, and another trip through ultraviolet rays, developer, and acid bath in order to dissolve off all of the aluminum on the wafer except that sitting inside our circuitry channels. Now each chip on the wafer should conduct electricity throughout itself.

The silver wafer edged with a barely-visible gray green silicon border takes another planetary ride now, this time in gold vapor. Using a process almost identical to that of aluminum evaporation, the wafers, clipped face down to the planetaries this time, receive a flat mustard-colored cloak of gold on their backs, later to bond with the gold in the package which holds the wiring and the chip in place.

Our wafers' wandering days are almost over. They journey out of the clean rooms to the Wafer Sort Area, where a computer tests each circuit separately, dropping a spot of red ink on any defective chips, and then they proceed to the Scribe and Break station in the assembly area. Each wafer sits on an automatic glass cutter and has a horizontal-vertical grid scored between each chip by a

A three-inch wafer being held by tweezers. The rainbow effect of the light is a typical phenomenon. Wafers are handled with special tools: special tweezers, vacuum wands, etc., during the entire wafer fabrication and assembly process. Skin oils would ruin a circuit.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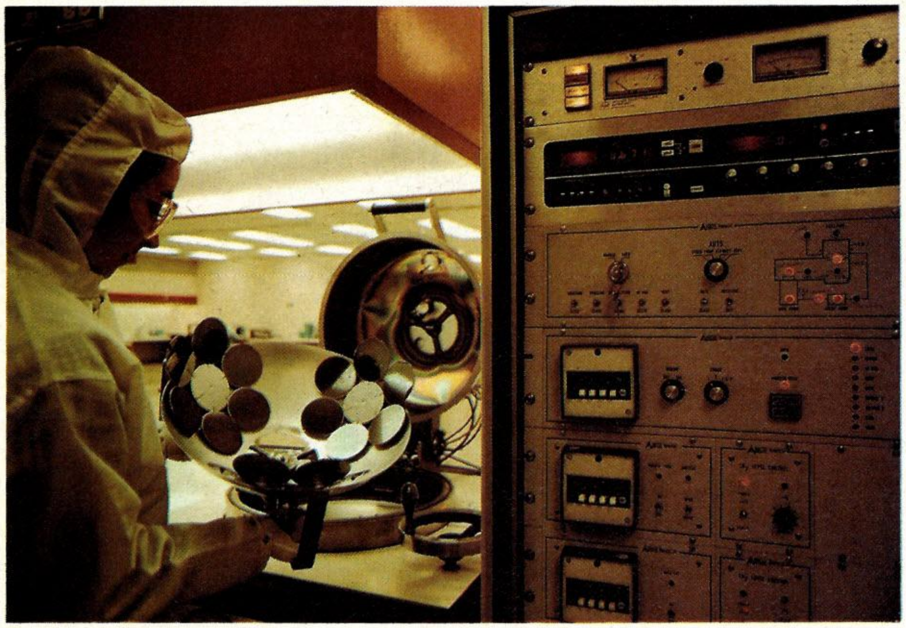

Intel

This station in the wafer fabrication area is called Aluminum Evaporation.

The chips are born and mature alongside 250 or 300 identical siblings on a wafer of silicon.

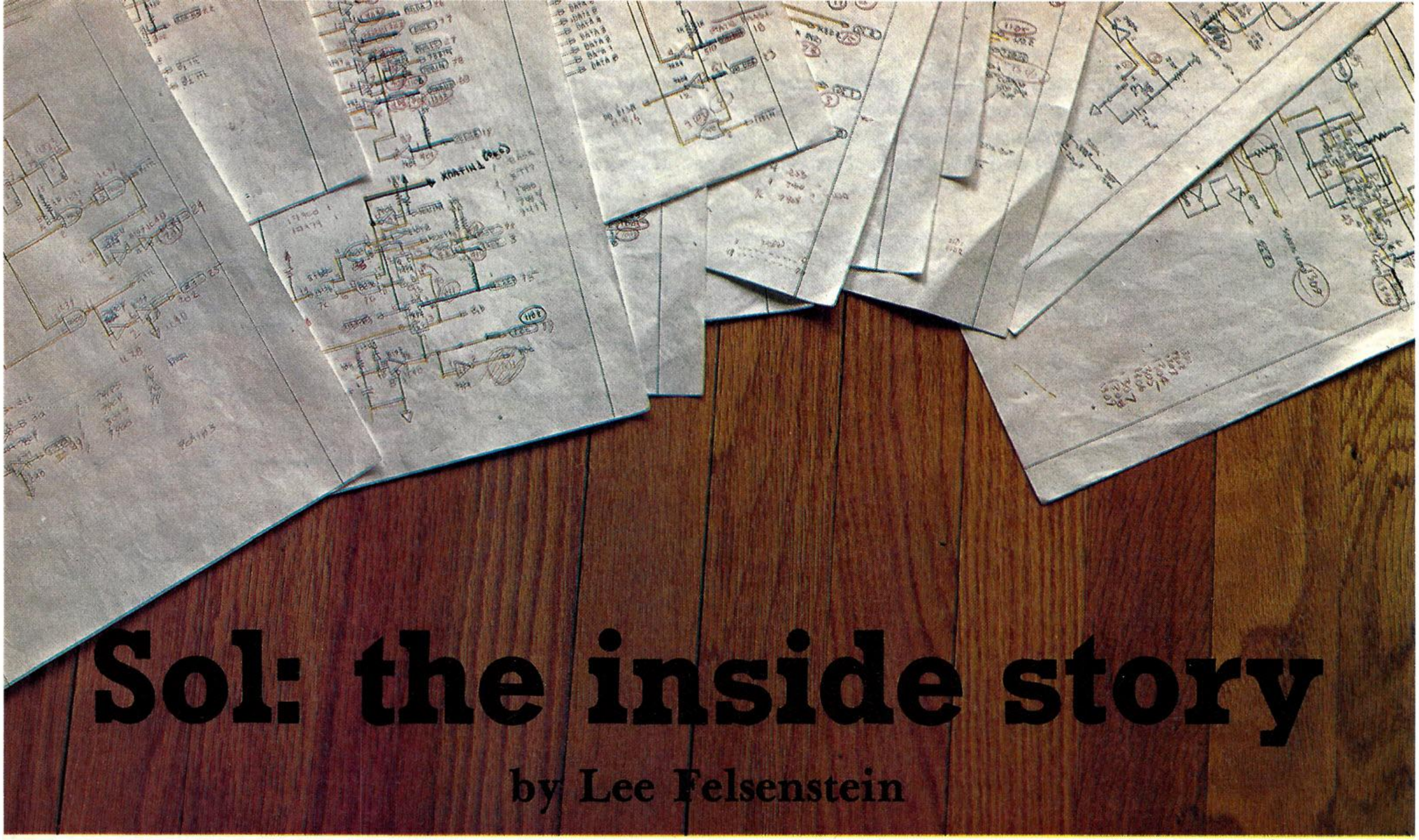
diamond-headed needle. Sandwiched between two cards of mylar, each wafer lies flat under a heavy cylindrical aluminum roller, about the size of a number two-and-a-half can of tomatoes. The cylinder rolls over the wafer sandwich as if it were a piece of pie crust, breaking the wafer at the scribed lines into 250 or 300 chips. (If the wafer hadn't been aligned properly during the first masking, it would have broken irregularly along the grain, splintering and distorting any chip oriented on it incorrectly.) The operator peels off the top layer of plastic and uses a vacuum wand to lift off each good chip individually. The red-dotted bad ones go on to an outside vendor who reclaims the gold from the back, refines it, and sells it back to Intel. Nothing else on the defective chips is recycled.

The remaining chips, in an ideal world all perfect, finally reach the business end of the assembly area. Each chip snuggles gold-side down into the very center of a package, something like a metal Lego block with a centipede's legs. Gold preform, a foil-like alloy of gold, bonds the gold backing on the chip to the gold which coats the cavity in the housing.

But there is still no way to get current from the package into the chip and out again. Like any other electrical appliance, the chip ultimately needs wires to link the works with the outside. But wires in Intel's scale look like gold and silver hairs from a newborn infant's head. The bonder, a cross between a sewing machine and a welder, solders these wires, one at a time, from a pad along the border of the chip to the appropriate gold spot on the inside edge of the package. The wires, fine as they are, provide a transition from the infinitesimal circuitry of the chip to the normal size of components used in electronic equipment. To protect this precisely trussed, fully contained electrical circuit from the ravages of dust, moisture, and the elements, the package is hermetically sealed with a lid of clear plastic or dark metal, according to the use and preference of the customer.

The package effectively determines the cost of the finished product, so, as the number of functions on the chip has increased over the years, the cost-per-function to the customer has plummeted, making the integrated-circuit business one of the few industries in the world that can brag that the more its products can do, the less they cost, relatively speaking. In the 18 March 1977 issue of *Science,* Robert Noyce predicted that we should have the technology to produce chips with 65 to 131 kilobits of memory by 1981 at a cost of about .0001 cents per bit.

I wonder if he'd be interested in engraving the Declaration of Independence in a fine calligraphic script on the head of a steel straight pin. . . . ▼



Sol: the inside story

by Lee Felsenstein

Lily Hou

"I designed the Sol!"

These words are made to be spoken from a pinnacle of technical authority, preferably by a gimlet-eyed Herr Doktor who pursues exact solutions to the nineteenth decimal place and who reigns over a limitless sea of subordinates slaving away over rows of drafting boards.

Or they could come from a furry little gopherlike creature with a piece of string for a belt who sleeps all day and occasionally surfaces to deposit a few dog-eared pages of scrawled diagrams with his custodians.

Since I fit neither of these descriptions, I hesitate to make that claim (except as part of a put-down), for it is only partly true. Besides, as I look over the reasons for making certain design decisions along the way, I am struck by the fact that most of those reasons had little to do with the ultimate advantages of the decisions.

The Sol, therefore, got designed—partly by me, partly by Bob Marsh, and partly by chance and circumstance. My description of that process is intended to instill confidence in those who feel that there are great secrets involved in the design of products and that mastery of most of the universe is a prerequisite to successful design. It is also intended as a warning to those who think that the design process is deterministic and uncomplicated.

WHAT IS THIS THING CALLED SOL?

For the benefit of future historians, I shall state that the Sol is a single-board computer built around the 8080 microprocessor and the S-100 bus structure. It incorporates an integral video alphanumeric display circuit, serial and parallel interfaces, and random-access and read-only memory on the board along with an audio cassette tape interface. A keyboard plugs into a connector on the board, and a video signal comes off through a coaxial cable. Regulated DC power is supplied to the board through another push-on connector, and that's all that is needed to make it compute.

Sol's main feature is a 100-pin edge connector that provides all the signals of the S-100 bus to any number of memory, I/O, or other peripheral cards available from different sources. An important secondary feature is the "personality module," a tiny (3-by-1½-inch) printed circuit card on which sits the ROM. The personality module plugs into a small edge connector on the Sol board. By this means the personality of the Sol can easily be changed without technical skill. Also, all the serial, parallel, and audio connectors are mounted along one edge of the card, requiring no external harness or connector assembly.

The Sol-10 and the Sol-20 both put this card, along with a power supply, into a metal chassis with walnut sides and a typewriter-style keyboard. The Sol-20 has a five-slot "daughter board" that plugs into the 100-pin edge connector and itself provides five more similar connectors, so that cards of the S-100 type can be plugged in within the cabinet. It has additional power supply capacity to feed these extra cards.

BEFORE THE BEGINNING

In 1974 I was helping to run a public-access "computerized bulletin board" system (called Community Memory), which was essentially a labor of love for me and several other people. It had two terminals in public where people could come in off the street and enter information items as well as search for them. Since the terminals were unattended, hardware reliability was an obvious problem, especially when we postulated much larger systems.

My way out of this future problem

was to design an all-purpose "convivial cybernetic device" as a terminal/concentrator/processor—in such a way that amateurs would be encouraged to get their hands on it. In theory, each place where one of these "Tom Swift Terminals" was installed would develop a computer club. Then, when a terminal broke down, relief would be a local matter, and people would not have to place their trust in a remote maintenance structure.

It was by placing a notice about this conceptual design on the system and inviting respondents to form a discussion group that I met Bob Marsh for the second time. (The first had been during our college days when we lived in the same co-op residence hall at Berkeley. We did not share many interests then.)

Now, however, Bob had raised himself to the state of an unemployed electronics engineer (self-taught) who had nearly won an encounter with a glorified version of Don Lancaster's TV Typewriter that he had built, improved, and fixed from scratch. After a while Bob suggested that I go in with him on the rental of a workshop. I agreed, and we signed a three-year lease on a garage in industrial Berkeley, commencing from January of 1975. I moved my workshop out of my living room, and Bob took up residence in the upstairs office, trying to find a product to manufacture. A plan to produce a limited-edition digital clock with a fancy wood case never materialized, which was a disappointment both for Bob and for Steve, a friend of his who did woodworking (we shall hear more of this later). Bob spent much time investigating the possibilities for a logic analyzer similar to others then available, doing much design before he gave it up as impractical.

In March 1975 I took Bob to the second meeting of the Homebrew Computer Club, where about twenty-five people stood around the first Altair 8800 to reach the area and watched it blink its front panel lights. That was all it could do, since it had no I/O circuitry and only 256 bytes of memory. There was a lot of empty space inside that cabinet.

Processor Technology was founded as a partnership in April of that year (I was not one of the partners) and began designing ROM, RAM, and I/O cards for the Altair. Incorporation followed in July, and I began to get bits and pieces of work—redrawing schematics, writing preliminary manuals, and other minor chores.

In July Bob finally got to me. He had a proposition: he would pay me to design the video display section of the Tom Swift Terminal. In October the VDM-1 video display module first saw Revision A. The Tom Swift Terminal never did get designed exactly as I dreamed it. But, as the hordes of amateur computer enthusiasts swarmed out of the woodwork, its purpose was being fulfilled.

THE SOL SOLUTION

I like to say that, in the process leading to the birth of the Sol, Leslie Solomon, technical editor of *Popular Electronics* magazine, performed the act equivalent to that of the male. I still don't know who solicited whom, but Les agreed to carry a construction article on "an intelligent terminal" on the cover if a working model could be supplied in thirty days. This proposal was made in the middle of November 1975. I was summoned to Bob's office.

Bob tactfully asked me if I thought such a project was impossible. I reluctantly admitted that I did not but strongly suggested that an unintelligent terminal be designed, mainly because I wanted badly to exercise the features designed into the VDM-1 for such an eventuality. Besides, I had already turned down an offer from Bob to design an 8080 CPU board for Processor Technology.

Alternate designs were roughed out and prices compared. Both were for terminals using the basic circuitry of the VDM-1. His had an 8080 thrown in, mine had decoders and counters. Mine was cheaper, but only by about ten dollars. Gradually I came to realize that if the inevitable were to happen, it would be better to be on the inside than on the outside. After a day or two of discussions, I agreed to contract to do the design. I pulled out of a volunteer project on the grounds that "the roof was about to fall in again." And somewhere in the midst of all this I looked up at Bob and said: "Let's advertise it as having 'the wisdom of Solomon.'" From the comment came the name Sol, which is meant to be written in biblical-movie-poster letters chiseled out of stone. Les will never live it down.

ROMtutorial ROMtutorial

Single Board Computer: *Electronic devices are built nowadays on "printed circuit cards" of fiberglass with patterns of copper foil instead of wires. In the old days, ten years ago, computers had hundreds of these boards, each containing a tiny portion of their electronics. Now things have shrunk so much that an entire computer can fit on one printed circuit board.*

Microprocessor: *the "thinking" section of a computer is called the central processing unit (CPU) or just the processor. If it's so small that you need a microscope to examine it, it's called a microprocessor.*

S-100 bus structure: *a bus is a wire connected to many places. Usually it's used to carry electricity for power, but, in a computer, very fast, low-power electrical impulses are sent between sections on buses. Since there are a lot of these signals happening at once, computer buses have a lot of wires in them. The S-100 is a 100-wire bus used by many personal computers. Because they all have the same pattern of four interconnections, the plug-in board from one will work (usually) when plugged into another S-100 machine. The S means standard.*

Integral video alphanumeric display circuit: *electronic circuitry which produces a signal that can be connected to a TV set and that causes the set to display letters and numbers on the screen. It is integral because it is built into the computer.*

ROMtutorial ROMtutorial

Serial and parallel interfaces: *An interface is the dividing line between two electronic devices. A wire or cable usually goes across an interface carrying electrically-coded information. If the cable carries several different signals at once, it's a parallel interface. If the information moves in a sequence through a single wire the interface is serial.*

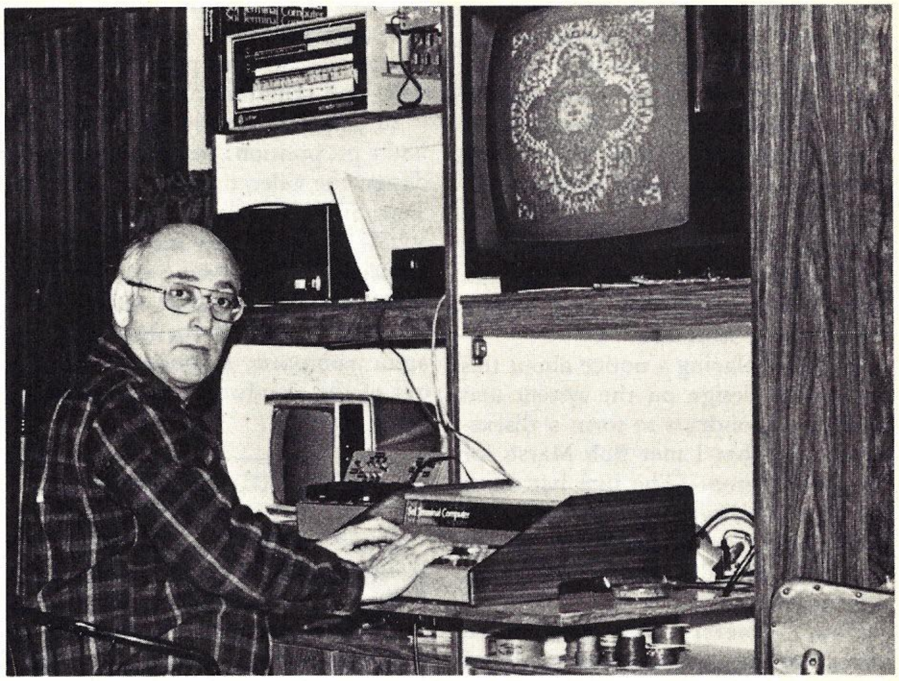
Random-access Memory: *memory like a set of pigeon-holes, into any of which the computer can put new information or from any of which it can read old information. The computer can choose any pigeon-hole (or address) at any time.*

Read Only Memory: *memory like a telephone directory which can only be read by the computer and not written in. It's used to hold instructions for the computer (the program).*

Push-on Connector: *a set of metal posts wired or soldered to electrical circuitry. A set of spring clips held in a plastic block can be pushed down onto these posts in order to make an electrical connection to a cable.*

Edge Connector: *a socket built as a long thin slot in a plastic block. A number of spring fingers are held in the block. If a printed circuit-board edge is pushed into the slot the spring fingers will "wipe" against both sides of the board and make contact with the copper foil patterns.*

I/O: *Input/Output. The electrical channels through which the computer moves information to and from the outside world.*



"Who, me?" Leslie Solomon, Technical Editor of Popular Electronics, *looks startled as the first Sol speaks its words of wisdom.*

In the process leading to the birth of the Sol, Leslie Solomon performed the act of the male. I still don't know who solicited whom.

Bob had already developed an architecture for the device. It involved taking the on-card memory and I/O devices, disconnecting the S-100 "DI" data input bus, and creating a separate low-drive "internal bus" that would get data to the CPU through a four-way data selector or multiplexer. One input of this would be the regular S-100 DI bus, another the internal bus, and the other two would be used for keyboard and parallel data inputs. The reasoning behind this was to minimize the need for high-power tristate drivers on the card and to allow the low-power tristate output features of the RAMs, ROMs, and UARTs to serve their intended functions.

I should explain here that designing for Bob Marsh can be somewhat of a trial. At least at that time, when he had little else with which to concern himself, he was continually turning up with new features and economies that he suddenly wanted incorporated in the design. He would explain the problem or opportunity and then preface his technical solution with an inevitable "All's ya got to do is. . . ." This would be forgivable if he were not so often right and possessed of a truly useful and valuable idea. Were the designer a prima donna, the relationship would terminate after the second such incident, with the designer fuming about "professionalism" and "interference." Of course, since my workshop was in the same room as his, I could not have gotten very far if I had wanted to stamp out in a rage. The situation did, however, call heavily on my sense of futility, absurdity, and ultimate irrelevance.

A few days after I started on Sol, Bob had another idea. He wanted all clocks on the card derived from a single crystal. The VDM-1 had been using a 13.4784-Mhz crystal, and Bob had been doing some division problems with his calculator. It seemed to him that not one but three relevant clock speeds could be extracted from this frequency, allowing operation with 2.5-Mhz and 3-Mhz 8080 chips if desired. I protested, but without grounds, and very soon gave in and designed a simple clock generator which allowed (through a variable-modulo flip-tail ring counter, if you must know) the kind of clocks Bob wanted.

Bob tactfully asked me if I thought the project was impossible.

After a decent interval Bob informed me that he would like to increase the crystal frequency to 14.31818, which would be necessary if color video peripherals were to operate with it. Please to redesign all relevant circuits accordingly. I fumed and grumbled but found a way out eventually. After all, the clock frequency to the 8080 would be of a 488-nanosecond period, a whole 1.8 percent shy of the spec sheet minimum! Why worry?

The biggest upset actually had the flimsiest reason. Bob wanted to be able to extend the S-100 bus of the Sol to an external cabinet through a flat ribbon-style cable, which came in 50-conductor maximum widths. With my avid agreement, Bob wanted to ensure that there were plenty of ground return lines sprinkled through this cable—a practice that had been neglected on the Altair and that probably caused many of the noise problems associated with it. To do this would require more than 100 wires.

Bob and I did some figuring while driving down to a Homebrew Club meeting, and he reached the conclusion that it would be permissible to take the DI and DO buses and connect them in parallel, making one single DIO bus. We assumed that every manufacturer who was anybody was doing the same as Processor Technology, using the DBIN signal from the 8080 as an enabling signal for data to the DI bus. DBIN could therefore be used at the Sol as a "direction signal" for the DIO bus and data could be sent both ways on one set of wires. Think of all the cable you'd save!

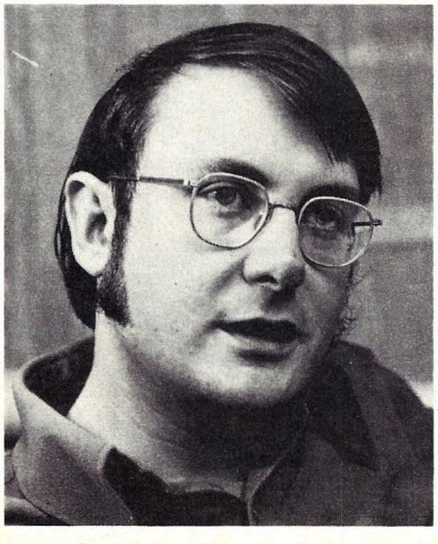
As it turned out, those eight extra traces saved on the Sol board nearly made the difference between a buildable board and an impossible one. The fact that some manufacturers' (notably MITS's) boards did not use the DBIN signal and were therefore useless with Sol, unless modified, is still a source of defensiveness in discussions of the design. I take the position that Bob made me do it, and he takes the position that history will absolve him.

As the design progressed, we realized that we were building a general-purpose computer rather than just "an intelligent terminal," but the decision was made to soft-pedal the fact until the last possible moment. Once published, all the fuss possible was to be made about its general-purpose nature; but until it actually saw print, it was to be treated first as a terminal.

To jump ahead a bit, when I finally delivered the working prototype to Les Solomon's desk and pointed out its salient features, his eyebrows began twitching. Why couldn't he, he wanted to know, plug in a ROM board with BASIC burned in (as he could do with a Bytesaver) and run stand-alone? I smiled my blandest smile and muttered, "Beats me."

THE BIG PUSH

Originally I had been given to believe that I would be required by the terms of the contract only to provide a schematic diagram and to help interpret it for the benefit of the layout artist. When it came time to start lay-



Lee Felsenstein after the deed.

ROMtutorial ROMtutorial

Multiplexer: *an electronic circuit which can choose one of several inputs and route the signals at that input to its output.*

Internal Bus: *Eight bus-type wires which are connected to most of the devices on the Sol which feed information to the processor. The information moves in eight-bit units (bytes), one wire for each bit.*

Tri-State Drivers: *electronic circuits used for feeding signals to a bus. They can either force the bus wire to a high voltage or a low voltage, or they can let the bus "float" at whatever voltage other drivers decree.*

Variable-modulo flip-tail ring counter: *an electronic worm continually chasing its tail. The worm's back is black and its belly is white. Each time around, it makes a half twist. A line of ants does close-order drill using the color of the worm as a cadence (clock signal). Since worms travel at a steady rate, the cadence can be changed by changing the length of the worm (variable-modulo).*

DI Bus: *Eight bus-type wires which carry electrical data signals from S-100 boards into the processor. Short for Data Input Bus.*

DO Bus: *Data Output Bus. Same as DI Bus, except that the electrical signals are carried out of the processor board to all of the S-100 boards.*

DBIN Signal: *Data Bus In. A timing signal which the microprocessor uses to tell anyone who cares that it can accept electrical data (one byte only) going in.*

ing tape, I discovered that I was expected to pitch in with a will and help stick down the many miles of crepe tape that would be required to produce the printed circuit artwork. Time was of the essence, as I agreed, and the layout artist who had been engaged was somewhat out of his depth with a 110-package layout to be done at four-to-one enlargement. Besides, he apparently didn't believe in making preliminary pencil sketches to test possible routings.

The crowning moment came when Bob changed his mind for the last time.

Steve the woodworker had built a large light table to Bob's specifications, and this was set up in the only available space in the now crowded garage—a loft above some offices that Processor had installed. I personally made sure that an electrical conduit running at forehead level was padded and tried to get someone to put up a fence to prevent one of us from stepping backwards off the edge of the loft. That, the knocking of heads against rafters, and the sticking or scratching of various parts of the head with needle-point X-acto knives, which we constantly had to hand, were the main hazards of working there.

In addition, there was the chill at night and the heat that accumulated during the day. People downstairs never had the same opinion about a comfortable temperature as we did. We soon settled into an insane schedule of fourteen- to seventeen-hour days, seven days a week. I kept going on orange juice, the younger layout man used Coke. He succumbed at the very end and I had to finish up alone. The task took almost three weeks of standing up looking down into a fluorescent-lit white background on which crawled worm tracks of black tape.

The crowning moment came when Bob changed his mind for the last time about which side he wanted the 100-pin connector to emerge from (this was determined by whether the S-100 boards were to mount above or below the Sol board). Layout had already started, and fortunately that connector lay in the other guy's area of concern. He had to cross over about seventy-five traces in order to flip the connector, and he did not succeed. Some traces were brought out to dead-end pads with no hole through them, leaving some of the pins to be connected by tack-soldered jumper wires later during assembly.

Sol Terminal Computer

Bonfield Associates

Bob Marsh with the Sol up and running. All's well that ends well—though in this case it seems to be only the beginning for Processor Technology.

I should point out that this printed circuit board was the prototype; no wire-wrap or other version had been made. Only two boards were ultimately produced (by a specialty shop run by a work addict), and one of them sits on my window ledge at home to remind me of how rough things can become. Besides, I like to point out my half of the layout and how obviously superior was my technique compared with the other half.

The other board I loaded with parts, tack-soldered with almost a hundred jumper wires out of sight on the rear side where traces were incomplete due to the hasty layout, checked out, and presented to the software people to see what they could do. I have no recollection whether that was before or after Christmas of that year; I think it was before.

IN THE BAG

Bob had laid out the basic outlines of the cabinet and had patched together a power supply and a sample keyboard. One of his design criteria from the absolute beginning was that the cabinet have walnut sides of a certain height or less. Steve had told him of a great bargain to be had from center-cut pieces of walnut, which were ordinarily almost thrown away. There is some cause to believe that the primary reason for the existence of the Sol was to provide an outlet for this inexpensive wood. At any rate, Steve is now in the wilds of Wisconsin running a mill to make walnut Sol sides.

As the project proceeded, Bob was undecided as to whether a cassette interface or drive would be included in the production version. As photographic deadlines approached, he decided to put a dummy cassette drive in the cabinet. This was to symbolize the fact that cassette tape would ultimately be available in one way or another—how he did not know. The text of the article, when it appeared, mentioned nothing about it, and the mysterious tape deck has proved to be

Carrying the Sol shrouded in two paper bags, we embarked for the big-time world of New York.

the biggest single source of questions from the readership of that article.

The printed circuit board was ready forty-five days after the start of the project. About sixty days from the go-ahead, the cabinetry, power supply, and software were coming down the home stretch. Bob scheduled a night flight to New York, to save money, and informed me that I was coming; everybody went into a final home-stretch panic lasting the better part of twenty-four hours.

We made the helicopter only because my watch was fast. Bob forgot to bring his tickets to the heliport and broke numerous traffic laws going back to get them. Carrying the Sol shrouded in two paper bags, we embarked for the big-time world of New York.

Of course we got no sleep on the plane and arrived an hour too early for our purposes. We went directly to Les Solomon's home and shared breakfast with him, discovered that the Sol wouldn't work (you could see it trying behind a veil of "snow"), then took the train to Les's offices on Park Avenue, where we met the boss and everyone else. Leaving behind a trail of excuses, we emplaned for Boston, where the folks from *Byte* magazine took us to dinner and drove us up to Peterborough, New Hampshire to see the snow. I conked out on this last trip, after attempting to stay awake by gorging myself at every available opportunity. I fear that I made a poor impression by so doing.

Back at the workbench a day or so later, I traced the trouble to a tiny speck of wire obviously loosed from the shield braid of the coaxial cable as it was stripped. This crumb had been captured underneath a socket, where it had plainly stayed during all the checkout without causing mischief. In transit it had shifted to the worst possible position—shorting two obscure but critical traces together. Murphy's Law confirmed!

After that it was bundle up again, this time myself alone—but carrying my oscilloscope and tool kit as well as the Sol. An hour or two of demonstration in the offices of *Popular Electronics* convinced them that Sol would indeed work. Then it was back home directly, where I passed "Go" and collected the balance of my lump payment.

DEBUT

A great deal of work remained to be done after the prototype Sol was finished. Bob wasn't through with suggesting new things and better ways—I suspect he never will be. One major change in the design bears pointing out, though.

The personality module, which owes its name to Don Lancaster, came about as a result of unpredictable EPROM supplies. Some way had to be found to plug in three different EPROMs without taking up extra area. The first suggestion was for a "piggyback" card with upright pins that plugged onto a row of socket connectors on the board. I take credit for extending this idea to one of a miniature printed-circuit plug-in card with a row of edge-connector "fingers" that would mate with a right-angle PC connector and be guided by rails so it could be changed from outside the cabinet. This leads to fantasies of employees swapping in game personality modules during lunch time and returning to the business modules when the whistle blows.

Almost everything except the circuit was redesigned between prototype and production, and even the circuit was the object of much straightening out of wrinkles. The printed-circuit board was totally re-laid out, and the layout was digitized for computerized photoplotting. More expediting, twenty-four-hour days, and dead runs from plane to plane.

In late August the Sol, in its production form, had its debut at the Atlantic City Personal Computing Show. I understand the cocktail party was splendid. Personally, I spent the time trying to trace down a bug that I was later told was in software. ▼

ROMtutorial ROMtutorial

BASIC: *A computer program which allows anyone to use the computer and get instantaneous feedback as to whether they are doing OK or making a mistake.*

Bytesaver: *An S-100 plug-in board which can write information supplied by the processor into special read-only memory chips. Once written, the information cannot be erased by the computer but it can be read. A trademark of Cromemco.*

EPROM: *Erasable Programmable Read-Only Memory. Used on things like the Bytesaver. A chip which will hold information indefinitely after being written, but which will forget the information if exposed to ultraviolet light (the cover of the chip is clear quartz).*

Right-angle PC Connector: *A printed circuit edge-connector with pins bent 90 degrees so that once it's soldered down to its own board the slot is parallel to the board. Now a printed circuit card pushed into the slot will be parallel to the "mother board" rather than perpendicular.*

TOOLS

BY JOSEPH WEIZENBAUM

The stories of man and of his machines are inseparably woven together. Machines have enabled man to transform his physical environment. With their aid he has plowed the land and built cities and dug great canals. These transformations of man's habitat have necessarily induced mutations in his societal arrangements. But even more crucially, the machines of man have strongly determined his very understanding of his world and hence of himself. Man is conscious of himself, of the existence of others like himself, and of a world that is, at least to some extent, malleable. Most importantly, man can foresee. In the act of designing implements to harrow the pliant soil, he rehearses their action in his imagination. Moreover, since he is conscious of himself as a social creature and as one who will inevitably die, he is necessarily a teacher. His tools, whatever their primary practical function, are necessarily also pedagogical instruments. They are then part of the stuff out of which man fashions his imaginative reconstruction of the world. It is within the intellectual and social world he himself creates that the individual prehearses and rehearses countless dramatic enactments of how the world might have been and what it might become. That world is the repository of his subjectivity. Therefore it is the stimulator of his consciousness and finally the constructor of the material world itself. It is this self-constructed world that the individual encounters as an apparently external force. But he contains it within himself; what confronts him is his own model of a universe, and, since he is part of it, his model of himself.

Man can create little without first imagining that he can create it. We can imagine the rehearsal of how he would use it that must have gone on in a stone-age man while he laboriously constructed his axe. Did not each of us recapitulate this ancestral experience when as small children we constructed primitive toys of whatever material lay within our reach? But tools and machines do not merely signify man's imaginativeness and its creative reach, and they are certainly not important merely as instruments for the transformation of a malleable earth: they are pregnant symbols in themselves. They symbolize the activities they enable, i.e., their own use. An oar is a tool for rowing, and it represents the skill of rowing in its whole complexity. No one who has not rowed can see an oar as truly an oar. The way someone who has never played one sees the violin is simply not the same, by very far, as the way a violinist sees it. A tool is also a model for its own reproduction and a script for the reenactment of the skill it symbolizes. That is the sense in which it is a pedagogic instrument, a vehicle for instructing men in other times and places in culturally acquired modes of thought and action. The tool as a symbol in all these respects thus transcends its role as a practical means toward certain ends: it is a constituent of man's symbolic recreation of his world.

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It must therefore inevitably enter into the imaginative calculus that constantly constructs his world. In that sense, then, the tool is much more than a mere device: it is an agent for change. It is even more than a fragment of a blueprint of a world determined for man and bequeathed to him by his forebearers—although it is that too.

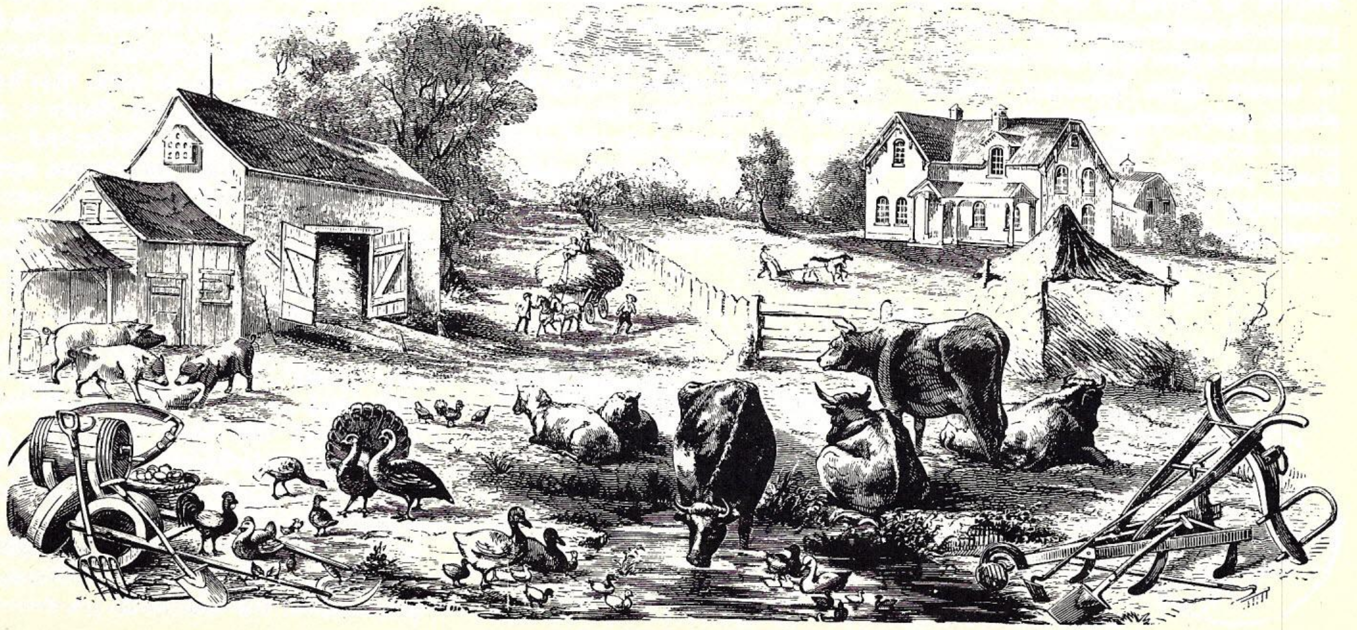
It is readily understandable that held weapons have direct effects on the imaginations of individuals who use them. When hunters acquired spears, for example, they must have seen themselves in an entirely new relationship to their world. Large animals which had earlier raided their foodstores and even attacked their children and which they feared, now became man's prey. Man's source of food grew, for now men could kill animals at a distance, including many species that had eluded them before. The effectively greater abundance of food must also have enlarged the domain over which they could range, thus increasing the likelihood that they would meet other people. Their experience of the world changed and so too must have their idea of their place in it.

The six-shooter of the nineteenth-century American West was known as the "great equalizer," a name that eloquently testifies to what that piece of hardware did to the self-image of guntoters who, when denuded of their weapons, felt themselves disadvantaged with respect to their fellow citizens. But devices and machines, perhaps known to (and certainly owned and operated by) only a relatively few members of society, have often influenced the self-image of its individual members and the world-image of the society as a whole quite as profoundly as have widely used hand tools. Ships of all kinds, for example, were instrumental in informing man of the vastness of his domain. They permitted different cultures to meet and to cross-fertilize one another. The seafarer's ships and all his other artifacts, his myths and legends, effectively transmitted his lore from generation to generation. And they informed the unconscious of those who stayed on the land as much as that of those who actually sailed. The printing press transformed the world even for those millions who, say, in Martin Luther's time, remained illiterate and perhaps never actually saw a book. And of the great masses of people all over the world whose lives were directly and dramatically changed by the industrial revolution, how many ever actually operated a steam engine? Nor is modern society immune to huge shocks administered as side effects of the introduction of new machines. The cotton-picking machine was deployed in the cotton fields of the American South beginning about 1955. It quickly destroyed the market for the only thing vast masses of black Southern agricultural workers had to sell: their labor. Thus began the mass migration of the American Black to the cities, particularly to such northern manufacturing centers as Detroit, Chicago, and New York, but also to the large Southern cities, such as Birmingham and Atlanta. Surely this enormous change in the demography of the United States, this internal migration of millions of its citizens, was and remains one of the principal determinants of the course of the American civil-rights movement. And that movement has nontrivially influenced the consciousness of every American at least, if not of almost every living adult anywhere on this earth.

The tool is much more than a device: it is an agent for change.

What is the compelling urgency of the machine that it can so intrude itself into the very stuff out of which man builds his world?

Many machines are functional additions to the human body, virtually prostheses. Some, like the lever and the steam shovel extend the raw muscular power of their individual operators; some, like the microscope, the telescope, and various measuring instruments, are extensions of man's sensory apparatus. Others extend the



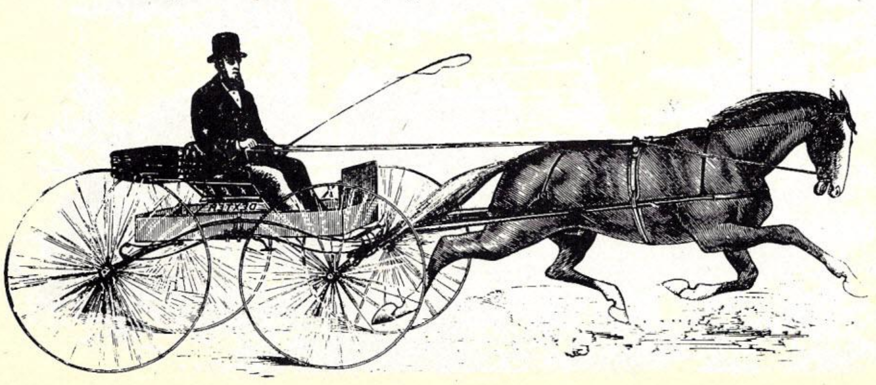
> **Modern society is not immune to huge shocks administered as side effects of the introduction of new machines.**

physical reach of man. The spear and the radio, for example, permit man to cast his influence over a range exceeding that of his arms and voice, respectively. Man's vehicles make it possible for him to travel faster and farther than his legs alone would carry him, and they allow him to transport great loads over vast distances. It is easy to see how and why such prosthetic machines directly enhance man's sense of power over the material world. And they have an important psychological effect as well: they tell man that he can remake himself. Indeed, they are part of the set of symbols man uses to recreate his past, i.e., to construct his history, and to create his future. They signify that man, the engineer, can transcend limitations imposed on him by the puniness of his body and of his senses. Once man could kill another animal only by crushing or tearing it with his hands; then he acquired the axe, the spear, the arrow, the ball fired from a gun, the explosive shell. Now charges mounted on missiles can destroy mankind itself. That is one measure of how far man has extended and remade himself since he began to make tools.

To construe the influence of prosthetic tools on man's transformation entirely in terms of the power they permitted man to aggregate to himself may invite a view of man's relationship to nature whose principal—indeed, almost sole—component is a raw power struggle. Man, in this view, finally conquered nature simply by mustering sufficient power to overcome natural space and time, to engineer life and death, and finally to destroy the earth altogether. But this idea is mistaken, even if we accept that man's eternal dream has been, not merely the discovery of nature, but its conquest, and that that dream has now been largely realized. For if victory over nature has been achieved in this age, then the nature over which modern man reigns is a very different nature from that in which man lived before the scientific revolution. Indeed, the trick that man turned and that enabled the rise of modern science was nothing less than the transformation of nature and of man's perception of reality.

The paramount change that took place in the mental life of man, beginning during roughly the fourteenth century, was in man's perception of time and consequently of space. Man had long ago noticed (and, we may suppose, thought about) regularities in the world about him. Alexander Marshack has shown that even Upper Paleolithic man (circa 30,000 B.C.) had a notation for lunar cycles that was, in Marshack's words, "already evolved, complex and sophisticated, a tradition that would seem to have been thousands of years old by this point." But from Classical antiquity until relatively recently, the regularity of the universe was searched for and perceived in great thematic harmonies. The idea that nature behaves systematically in the sense we understand it—i.e., that every part and aspect of nature may be isolated as a subsystem governed by laws describable as functions of time—this idea could not have been even understood by people who perceived time, not as a collection of abstract units (i.e., hours, minutes, and seconds), but as a sequence of constantly recurring events.

Times of day were known by events, such as the sun standing above a specific pile of rocks, or, as Homer tells us, by tasks begun or ended, such as the yoking of the oxen (morning) and the unyoking of the oxen (evening). Durations were indicated by reference to common tasks, e.g., the time needed to travel a well-known distance or to boil fixed quantities of water. Seasonal times were known by recurring seasonal events, e.g., the departure of birds. Until Darwin's theory of evolution began to sink into the stream of commonly held ideas, i.e., to become "common sense," people knew that the world about them—the world of reproducing plants and animals, of rivers that flowed and dried up and flowed again, of seas that pulsed in great tidal rhythms, and of the ever-repeating spectacles in the heavens—had always existed, and that its fundamental law was eternal periodicity. Cosmological time, as well as the time perceived in daily life, was therefore a sort of complex beating, a repeating and echoing of events. Perhaps we can vaguely understand it by contemplating, say, the great fugues of Bach. But a special form of contemplation is required of us: we must not think in the modern manner, i.e., of Bach as a "problem solver," or of each of his *opera* in his *Art of the Fugue* as being his increasingly refined "solution" to a problem he had originally set himself. Instead we must think that Bach had the whole plan in his mind all the time, that he thought of the *Art of the Fugue* as a unified work with no beginning and no end, itself eternal like the cosmos, and like it enormously intricate in its connections, circles within circles within circles. We might then find it possible to think of life as having been not merely punctuated but entirely suffused by this kind of music, both on the grand cosmological-theological scale and on the small day-to-day level. Such time is a revolution of cycles and epicycles within cycles, not the receptacle of a uniformly flowing progression of abstract moments we now "know" it to be. And nature itself consisted, to be sure, of individual phenomena, but individual phenome-



na that were constantly repeating metamorphoses of themselves, and hence were permanent, eternal. "What is eternal is circular, and what is circular is eternal," Aristotle said, and even Galileo still believed the universe to be eternal and to be governed by recurrence and periodicity.

Darwin's understanding of time was radically different. He saw nature itself as a process in time and the individual phenomena of nature as irreversible metamorphoses. But he was far from being the originator of the idea of progress that is now so much with us. Indeed, he would not have been able to think his thoughts at all, if something very nearly like our current ideas of time had not already been an integral part of the common sense of his era.

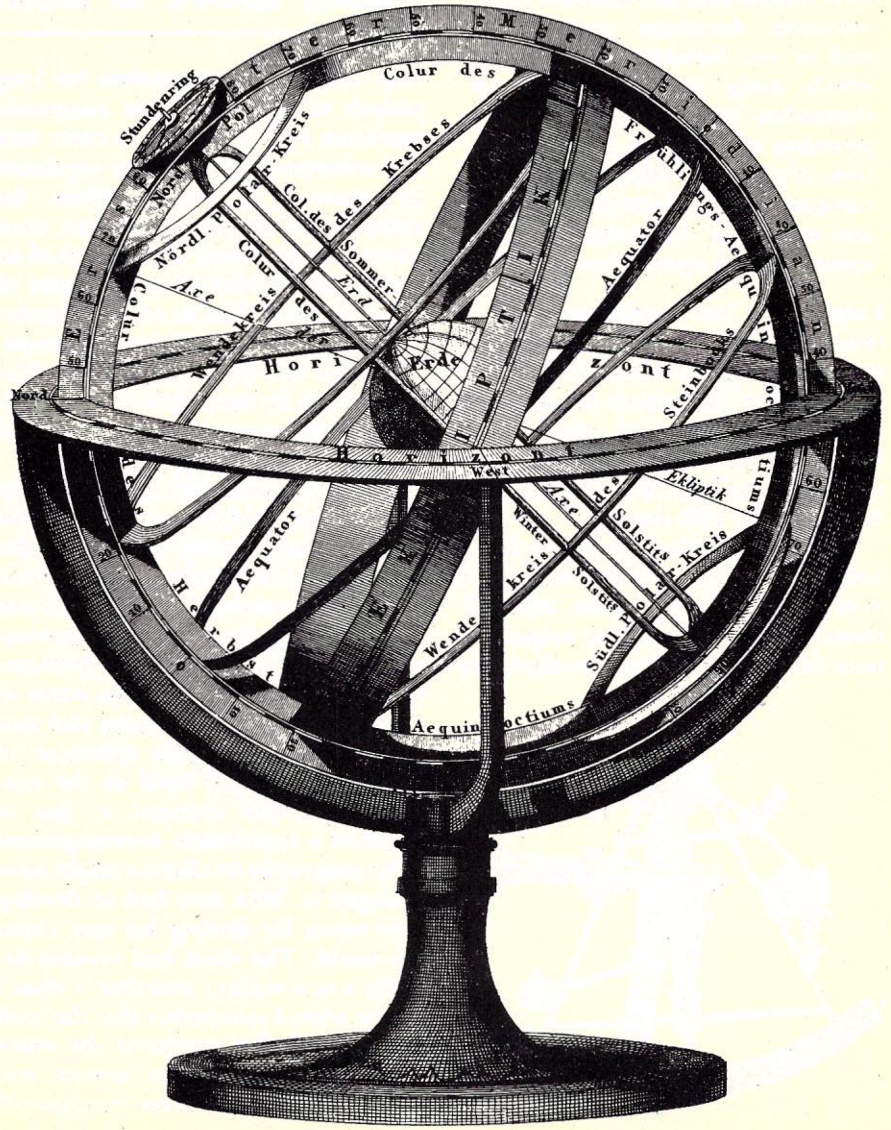
How man's perception of time changed from that of the ancients to ours illuminates the role played by another kind of machine (one that is not prosthetic) in man's transformation from a creature of and living in nature to nature's master.

The clock is not a prosthetic machine; its product is not an extension of man's muscles or senses, but hours, minutes, and seconds, and today even micro-, nano-, and pico-seconds. Lewis Mumford calls the clock, not the steam engine, "the key machine of the modern industrial age." In the brilliant opening chapter of his *Technics and Civilization,* he describes, among other things, how during the Middle Ages the ordered life of the monasteries affected life in the communities adjacent to them.

> "The monastery was the seat of a regular life. . . . the habit of order itself and the earnest regulation of time-sequences had become almost second nature in the monastery. . . . the monasteries—at one time there were 40,000 under the Benedictine rule—helped to give human enterprise the regular collective beat and rhythm of the machine; for the clock is not merely a means of keeping track of the hours, but of synchronizing the actions of men. . . . by the thirteenth century there are definite records of mechanical clocks, and by 1370 a well-designed 'modern' clock had been built by Heinrich von Wyck at Paris. Meanwhile, bell towers had come into existence, and the new clocks, if they did not have, till the fourteenth century, a dial and a hand that translated the movement of time into a movement through space, at all events struck the hours. The clouds that could paralyze the sundial. . . . were no longer obstacles to time-keeping: summer or winter, day or night, one was aware of the measured clank of the clock. The instrument presently spread outside the monastery; and the regular striking of the bells brought a new regularity into the life of the workman and the merchant. The bells of the clock tower almost defined urban existence. Time-keeping passed into time-serving and time-accounting and time-rationing. As this took place, Eternity ceased gradually to serve as the measure and focus of human actions."

The clock is an autonomous machine whose advent signaled man's rejection of direct experience.

Mumford goes on to make the crucial observation that the clock "disassociated time from human events and helped create the belief in an independent world of mathematically measurable sequences: the special world of science." The importance of that



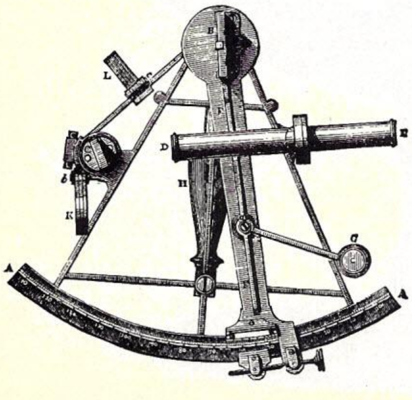
Everyone who invents a new tool puts some portion of an apparently stable world in peril and no one can predict what will emerge in its place.

effect of the clock on man's perception of the world can hardly be exaggerated. Our current view of time is so deeply ingrained in us, so much "second nature" to us, that we are virtually incapable any longer of identifying the role it plays in our thinking. Alexander Marshack remarks:

> "The concept of the time-factored process in the hard sciences is today almost tautological, since all processes, simple or complex, sequential or interrelated, finite or infinite, develop or continue and have measurable or estimable rates, velocities, durations, periodicities, and so on. However, the sciences which study these processes are themselves 'time-factored,' since the processes of cognition and recognition, of planning, research, analysis, comparison, and interpretation are also sequential, interrelated, developmental and cumulative."

Indeed, the two fundamental equations of physics that every high school student knows are $F = ma$ and $E = mc^2$ The a in the first stands for acceleration, i.e., a change of velocity with time, and the c in the second stands for the velocity of light, i.e., the displacement of light with time.

I mention the clock here not merely because it was a crucial determinant of man's thinking—there were, after all, many other inventions that helped initiate the new scientific rationalism; for example, lines of longitude and latitude on the globe—but to show that prosthetic machines alone do not account for man's gain of power over nature. The clock is clearly not a prosthetic machine; it extends neither man's muscle power nor his senses. It is an autonomous machine.



Many machines are automatic in the sense that, once they are turned on, they may run by themselves for long periods of time. But most automatic machines have to be set to their task and subsequently steered or regulated by sensors or by human drivers. An autonomous machine is one that, once started, runs by itself on the basis of an internalized model of some aspect of the real world. Clocks are fundamentally models of the planetary system. They are the first autonomous machines built by man, and until the advent of the computer they remained the only truly important ones.

The pig principle: if something is good, more is better.

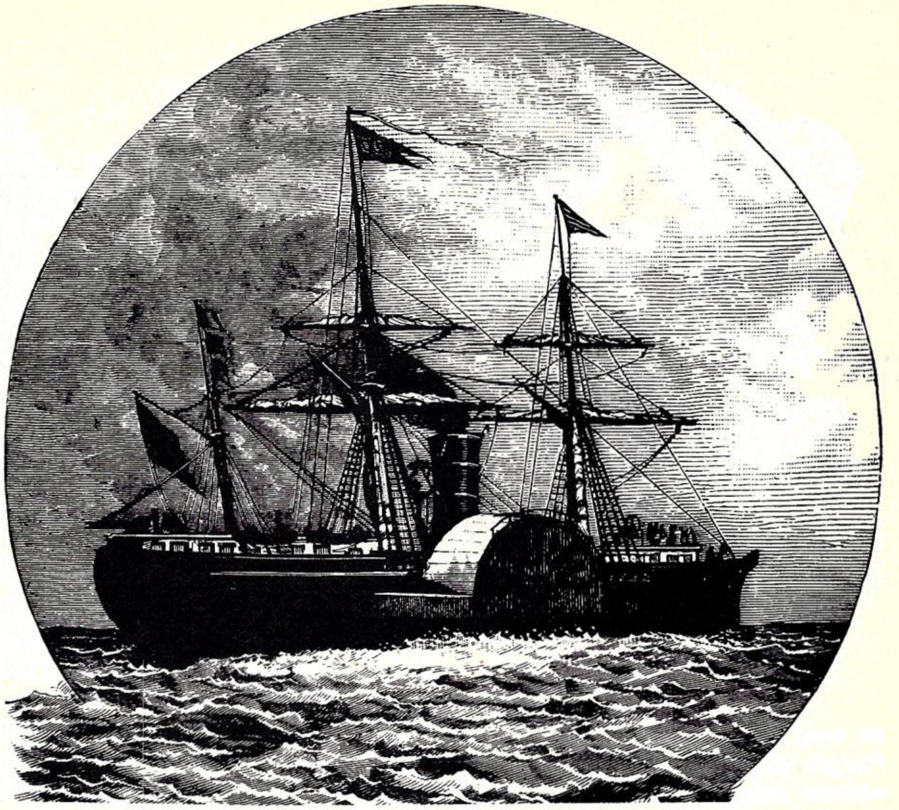
Where the clock was used to reckon time, man's regulation of his daily life was no longer based exclusively on, say, the sun's position over certain rocks or the crowing of a cock, but was now based on the state of an autonomously behaving model of a phenomenon of nature. The various states of this model were given names and thus reified. And the whole collection of them superimposed itself on the existing world and changed it, just as much as a cataclysmic rearrangement of its geography or climate might have changed it. Man now had to develop new senses for finding his way about the world. The clock had created literally a new reality; and that is what I meant when I said earlier that the trick man turned that prepared the scene for the rise of modern science was nothing less than the transformation of nature and of his perception of reality. It is important to realize that this newly created reality was and remains an impoverished version of the older one, for it rests on a rejection of those direct experiences that formed the basis for, and indeed constituted, the old reality. The feeling of hunger was rejected as a stimulus for eating; instead, one ate when an abstract model had achieved a certain state, i.e., when the hands of a clock pointed to certain marks on the clock's face (the anthropomorphism here is highly significant too), and similarly for signals for sleep and rising, and so on.

This rejection of direct experience was to become one of the principal characteristics of modern science. It was imprinted on western European culture not only by the clock but also by the many prosthetic sensing instruments, especially those that reported on the phenomena they were set to monitor by means of pointers whose positions were ultimately translated into numbers. Gradually at first, then ever more rapidly and, it is fair to say, ever more compulsively, experiences of reality had to be representable as numbers in order to appear legitimate in the eyes of the common wisdom. Today enormously intricate manipulations of often huge sets of numbers are thought capable of producing new aspects of reality. These are validated by comparing the newly derived numbers with pointer readings on still more instruments that mediate between man and nature, and which, of course, produce still more numbers.

"The scientific man has above all things to strive at self-elimination in his judgments," wrote Karl Pearson in 1892. Of the many scientists I know, only a very few would disagree with that statement. Yet it must be acknowledged that it urges man to strive to become a disembodied intelligence, to himself become an instrument, a machine. So far has man's initially so innocent liaison with prostheses and pointer readings brought him. And upon a culture so fashioned burst the computer.

"Every thinker," John Dewey wrote,

"puts some portion of an apparently stable world in peril and no one can predict what will emerge in its place." So too does everyone who invents a new tool or, what amounts to the same thing, finds a new use for an old one. The long historical perspective which aids our understanding of Classical antiquity, of the Middle Ages, and of the beginnings of the Modern Age also helps us to formulate plausible hypotheses to account for the new realities which emerged in those times to replace older ones imperiled by the introduction of new tools. But as we approach the task of understanding the warp and woof of the stories that tell, on the one hand, of the changing consciousness of modern man, and, on the other, of the development of contemporary tools and particularly of the computer, our perspective necessarily flattens out. We have little choice but to project the lessons yielded by our understanding of the past, our plausible hypotheses, onto the present and the future. And the difficulty of that task is vastly increased by the fact that modern tools impact on society far more critically in a much shorter time than earlier ones did.

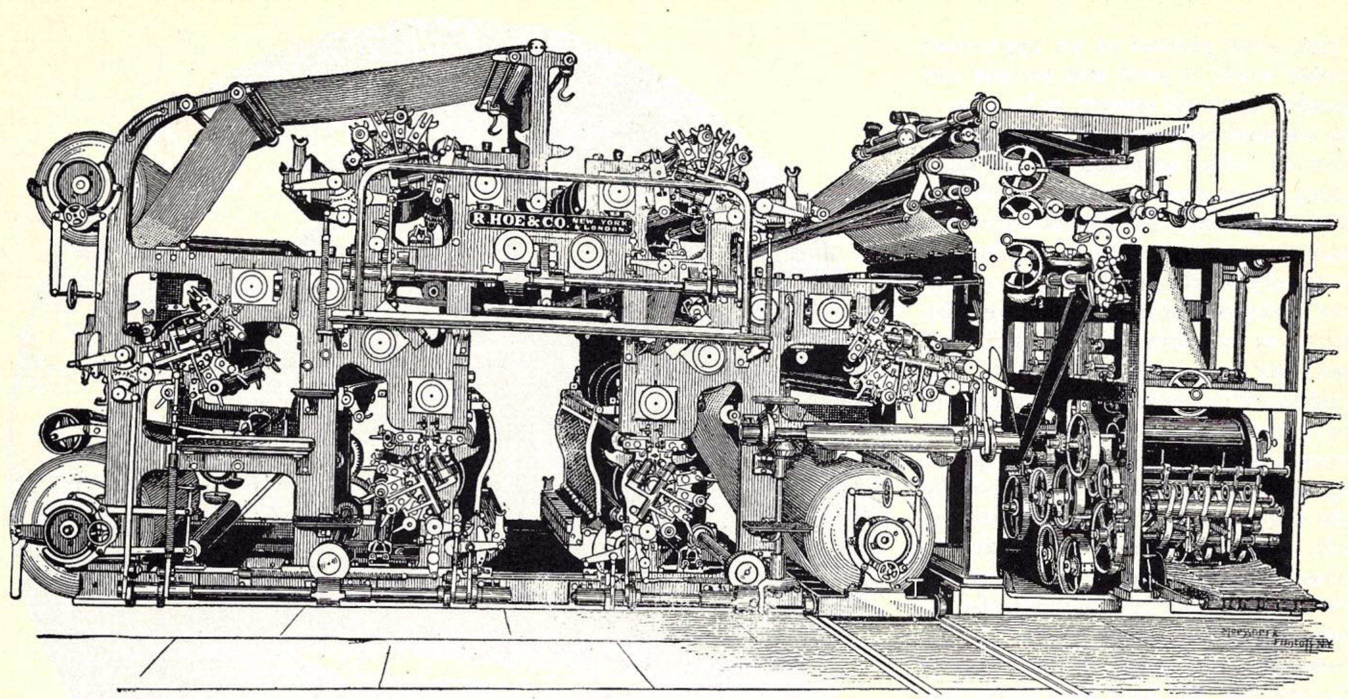


The impulse the clock contributed toward the alienation of man from nature required centuries to penetrate and decisively affect mankind as a whole. And even then, it had to synergistically combine with many other emerging factors to exercise its influence. The steam engine arrived when, in the common-sense view, time and space were already quantified. An eternal nature governed by immutable laws of periodicity implied a mandate, one made explicit in holy books and exercised by institutional vicars of the eternal order. That quasi-constitutional, hence constrained, authority had long since been displaced by, for example, the relatively unconstrained authority of money, i.e., of value quantified, and especially the value of a man's labor quantified. These and many other circumstances combined to make it possible for the steam engine to eventually transform society radically. Later tools, e.g., the telephone, the automobile, radio, impinged on a culture already enthralled by what economists call the pig principle: if something is good, more is better. The hunger for more communication capacity and more speed, often stimulated by the new devices themselves, as well by new marketing techniques associated with them, enabled their rapid spread throughout society and society's increasingly rapid transformation under their influence.

Were all computers suddenly to disappear, most of the modern world would be thrown into utter chaos.

When the first telegraph line connecting Texas with New York was laid, doubts were expressed as to whether the people in those places would have anything to say to one another. But by the time the digital computer emerged from university laboratories and entered the American business, military, and industrial establishments, there were no doubts about its potential utility. To the contrary, American managers and technicians agreed that the computer had come along just in time to avert catastrophic crises: were it not for the timely introduction of computers, it was argued, not enough people could have been found to staff the banks, the ever increasingly complex communication and logistic problems of American armed forces spread all over the world could not have been met, and trading on the stock and commodity exchanges could not have been maintained. The American corporation was faced with a "command and control" problem similar to that confronting its military counterpart. And like the Pentagon, it too was increasingly diversified and internationalized. Unprecedentedly large and complex computational tasks awaited American society at the end of the Second World War, and the computer, almost miraculously it would seem, arrived just in time to handle them.

In fact, huge managerial, technological, and scientific problems had been solved without the aid of electronic computers in the decades preceding the Second World War and especially during the war itself. A dominant fraction of the industrial plant of the United States was coordinated to provide the tools of war—foodstuffs, clothing, etc.—and to supply the required transport to vast armies spread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all over the globe. The Manhattan Project produced the atomic bomb without using electronic computers; yet the scientific and engineering problems solved under its auspices required probably more computations than had been needed for all astronomical calculations performed up to that time. The magnitude of its managerial task surely rivaled that of the Apollo Project of the sixties. Most people today probably believe that the Apollo Project could not have been managed without computers. The history of the Manhattan Project seems to contradict that belief. There are corresponding beliefs about the need for computers in the management of large corporations and of the military, about the indispensability of computers in modern scientific computations, and, indeed, about the impossibility of pursuing modern science and modern commerce at all without the aid of computers.

The capacity of the human mind for sloppy thinking and rationalizing is immense.

I am sure that, had computers attained their present sophistication by 1940, technicians participating in the Manhattan Project would have sworn that it too would have been impossible without computers. And we would have had similarly fervent testimony from the designers of Second World War aircraft, and from the managers of logistics of that war. If Germany had had computers from the outset of Hitler's dictatorship, common sense would today hold that only with the aid of computers could the Nazis have controlled the German people and implemented the systematic transportation of millions of people to death camps and their subsequent murder. But the Second World War was fought, and the millions did die, when there were still no computers.

The belief in the indispensability of the computer is not entirely mistaken. The computer becomes an indispensable component of any structure once it is so thoroughly integrated with the structure, so enmeshed in various vital substructures, that it can no longer be factored out without fatally impairing the whole structure. That is virtually tautology. The utility of this tautology is that it can reawaken us to the possibility that some human actions, e.g., the introduction of computers into some complex human activities, may constitute an irreversible commitment. It is not true that the American banking system or the stock and commodity markets or the great manufacturing enterprises would have collapsed had the computer not come along "just in time." It is true that the specific way in which these systems actually developed in the past two decades, and are still developing, would have been impossible without the computer. It is true that, were all computers to suddenly disappear, much of the modern industrialized and militarized world would be thrown into great confusion and possibly utter chaos. The computer was not a prerequisite to the survival of modern society in the post-war period and beyond; its enthusiastic, uncritical embrace by the most "progressive" elements of American government, business, and industry quickly made it a resource essential to society's survival *in the form* that the computer itself had been instrumental in shaping.

In 1947 J. W. Forrester wrote a memorandum to the U.S. Navy "On the Use of Electronic Digital Computers as Automatic Combat Information Centers." Commenting on subsequent developments in 1961, he wrote,

> "one could probably not have found [in 1947] five military officers who would have acknowledged the possibility of a machine's being able to analyze the available information sources,

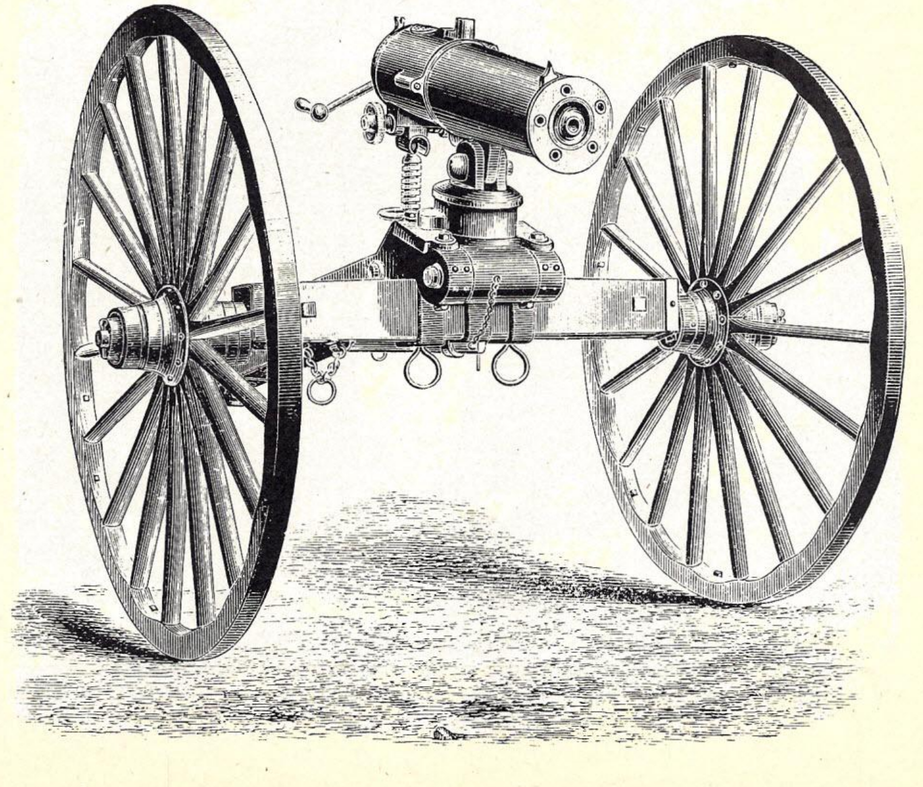
The computer was used to conserve America's social and political institutions, buttressing them, at least temporarily, against enormous pressures for change.

> the proper assignment of weapons, the generation of command instructions, and the coordination of adjacent areas of military operations. . . . During the following decade the speed of military operations increased until it became clear that, regardless of the assumed advantages of human judgment decisions, the internal communication speed of the human organization simply was not able to cope with the pace of modern air warfare. This inability to act provided the incentive."

The decade of which Forrester speaks was filled with such incentives, with discoveries that existing human organizations were approaching certain limits to their ability to cope with the ever faster pace of modern life. The image Forrester invokes is of small teams of men hurrying to keep up with events but falling ever further behind because things are happening too fast and there is too much to do. They have reached the limit of the team's "internal speed." Perhaps this same imagery may serve as a provocative characterization also for teams of bank clerks frantically sorting and posting checks in the middle of the night, attacking ever larger mountains of checks that must, according to law, be cleared by a fixed deadline. Perhaps all, or at least many, of the limits of other kinds that were being approached during that decade may usefully be so characterized. After all, it is ultimately the "internal speed" of some human organization that will prove the limiting factor when, say, an automobile firm attempts to run a production line capable of producing an astronomical variety of cars at a high and constant rate, or when, say, some central government agency takes the responsibility for guarding millions of welfare clients against the temptation to cheat by closely monitoring both their welfare payments and whatever other income they may, possibly illicitly, receive.

The "inability to act" which, as Forrester points out, "provided the incentive" to augment or replace the low-internal-speed human organizations with computers, might in some other historical situation have been an incentive for modifying the task to be accomplished, perhaps doing away with it altogether, or for restructuring the human organizations whose inherent limitations were, after all, seen as the root of the trouble. It may be that the incentive provided by the military's inability to cope with the increasing complexity of air warfare in the 1950's could have been translated into a concern, not for mustering techniques to enable the military to keep up with their traditional missions, but for inventing new human organizations with new missions, missions relevant to more fundamental questions about how peoples of diverse interests are to live with one another. But the computer was used to build, in the words of one air force colonel, "a servomechanism spread out over an area comparable to the whole American continent," that is, the SAGE air-defense system. Of course, once "we" had such a system, we had to assume "they" had one too. We therefore had to apply our technology to designing offensive weapons and strategies that could overpower "our" defenses, i.e., "their" presumed defenses. We then had to assume that "they" had similar weapons and strategies and therefore. . ., and so on to today's MIRVs and MARVs and ABMs.

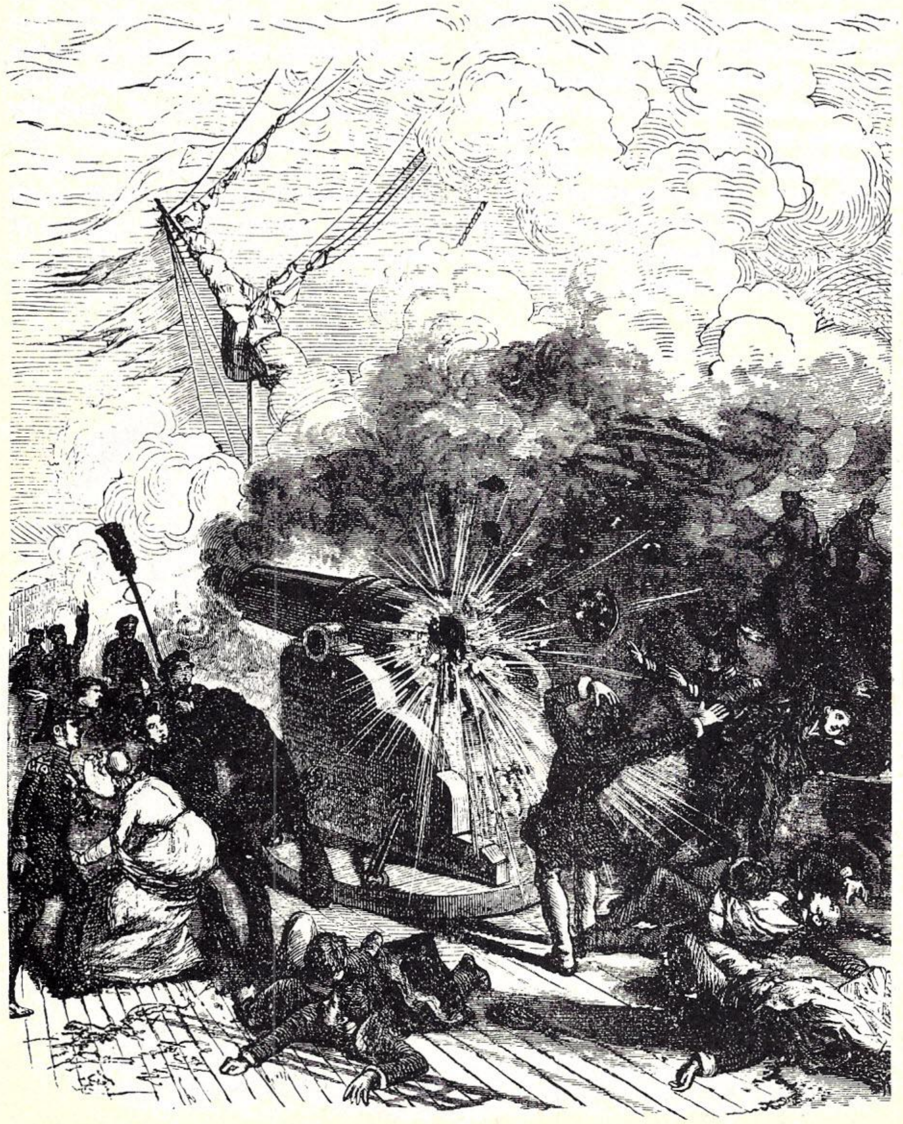
It may be that the people's cultivated and finally addictive hunger for private automobiles could have been satiated by giving them a choice among, say, a hundred vehicles that actually differ substantially from one another, instead of a choice among the astronomical number of basically identical "models" that differ only trivially from one another. Indeed, perhaps the private automobile could have been downgraded as a means of personal transportation in favor of mass transit in, and passenger rail be-



tween, the cities. But the computer was used to automate the flow of parts to automobile production lines so that people could choose from among millions of trivial options on their new cars.

It may be that social services such as welfare could have been administered by humans exercising human judgment if the dispensing of such services were organized around decentralized, indigenous population groupings, such as neighborhoods and natural regions. But the computer was used to automate the administration of social services and to centralize it along established political lines. If the computer had not facilitated the perpetuation and "improvement" of existing welfare distribution systems—hence of their philosophical rationales—perhaps someone might have thought of eliminating much of the need for welfare by, for example, introducing negative income tax. The very erection of an enormously large and complex computer based welfare administration apparatus, however, created an interest in its maintenance and therefore in the perpetuation of the welfare system itself. And such interests soon become substantial barriers to innovation even if good reasons to innovate later accumulate. In other words, many of the problems of growth and complexity that pressed insistently and irresistibly for response during the postwar decades could have served as incentives for social and political innovation. An enormous acceleration of social invention, had it begun then, would now seem to us as natural a consequence of man's predicament in that time as does the flood of technological invention and innovation that was actually stimulated.

A person falling into a manhole is rarely helped by making it possible for him to fall faster.



Yes, the computer did arrive "just in time." But in time for what? In time to save—and save very nearly intact, indeed, to entrench and stabilize—social and political structures that otherwise might have been either radically renovated or allowed to totter under the demands that were sure to be made on them. The computer, then, was used to conserve America's social and political institutions. It buttressed them and immunized them, at least temporarily, against enormous pressures for change. Its influence has been substantially the same in other societies that have allowed the computer to make substantial inroads upon their institutions: Japan and Germany immediately come to mind.

The invention of the computer put a portion of an apparently stable world in peril, as it is the function of almost every one of man's creative acts to do. And, true to Dewey's dictum, no one could have predicted what would emerge in its place. But of the many paths to social innovation it opened to man, the most fateful was to make it possible for him to eschew all deliberate thought of substantive change. That was the option man chose to exercise. The arrival of the Computer Revolution and the founding of the Computer Age have been announced many times. But if the triumph of a revolution is to be measured in terms of the profundity of the social revisions it entrained, then there has been no computer revolution. And however the present age is to be characterized, the computer is not eponymic of it.

To say that the computer was initially used mainly to do things pretty much as they had always been done, except to do them more rapidly or, by some criteria, more efficiently, is not to distinguish it from other tools. Only

rarely, if indeed ever, are a tool and an altogether original job it is to do, invented together. Tools as symbols, however, invite their imaginative displacements into other than their original contexts. In their new frames of reference, that is, as new symbols in an already established imaginative calculus, they may themselves be transformed, and may even transform the originally prescriptive calculus. These transformations may, in turn, create entirely new problems which then engender the invention of hitherto literally unimaginable tools. In 1804, a hundred years after the first stationary steam engines of Newcomen and Savery had found common use in England to, for example, pump water out of mines, Trevithik put a steam engine on a carriage and the carriage on the tracks of a horse-tramway in Wales. This ripping out of context of the stationary steam engine and its displacement into an entirely new context transformed the engine into a locomotive, and began the transformation of the horse-tramway into the modern railroad. And incidentally, since it soon became necessary to guard against collisions of trains traveling on the same track, a whole new signaling technology was stimulated. New problems had been created and, in response to them, new tools invented.

It is noteworthy that Thomas Savery, the builder of the first steam engine that was applied practically in industry (circa 1700), was also the first to use the term "horsepower" in approximately its modern sense. Perhaps the term arose only because there were so many horses when the steam engine replaced them, not only in its first incarnation as a stationary power source, but also in its reincarnation as a locomotive. Still, the term "horsepower," so very pointed in its suggestiveness, might well have provoked Trevithik's imagination to probe in the direction it finally moved, to make the creative leap that combined the steam engine and the horse-tramway in a single unified frame of reference. Invention involves the imaginative projection of symbols from one existing, and generally well-developed, frame of reference to another. It is to be expected that some potent symbols will survive the passage nearly intact, and will exert their influence on even the new framework.

Computers had horses of another color to replace. Before the first modern electronic digital computers became available for what we now call business data processing—that is, before the acquisition of UNIVAC 1 by the U.S. Bureau of the Census in 1951—many American businesses operated large so-called "tab rooms." These rooms housed machines that could punch the same kind of cards (now commonly, if often mistakenly, called IBM cards) that are still in use today, sort these cards according to arbitrary criteria, and "tabulate" decks of such cards, i.e., list the information they contained in long printed tables. Tab rooms produced mountains of management reports for American government and industry, using acres of huge clanking mechanical monsters. These machines could perform only one operation on a deck of cards at a time. They could, for example, sort the deck on a specific sorting key. If the sorted deck had to be further sorted according to yet another criterion, the new criterion had to be manually set into the machine and the deck fed through the machine once more. Tab rooms were the horsetramways of business data processing, tab machines the horses.

In principle, even the earliest commercially available electronic computers, the UNIVAC 1's, made entirely new and much more efficient data-processing techniques possible, just as, in principle, the earliest steam engines could already have been mounted on carriages and the carriages on tracks. Indeed, during and just after the Second World War, the arts of operations research and systems analysis, on which the sophisticated use of computers in business was ultimately grounded, were developed to very nearly their full maturity. Still, business used the early computers to simply "automate" its tab rooms, i.e., to perform exactly the earlier operations, only now automatically and, presumably, more efficiently. The crucial transition, from the business computer as a mere substitute for work-horse tab machines to its present status as a versatile information engine, began when the power of the computer was projected onto the framework already established by operations research and systems analysis.

It must be added here that although the railroad in England became important in its own right—it employed many workers, for example—it also enormously increased the importance of many other forms of transportation. Similarly, the synergistic combination of computers and systems analysis played a crucial role in the creation and growth of the computer industry. It also breathed a new vitality into systems analysis as such. During the first decade of the computer's serious invasion of business, when managers often decided their businesses needed computers even though they had only the flimsiest bases for such decisions, they also often undertook fairly penetrating systems analyses of their operations in order to determine what their new computers were to do. In a great many cases such studies revealed opportunities to improve operations, sometimes radically, without introducing computers at all. Nor were computers used in the studies themselves. Often, of course, computers were installed anyway for reasons of, say, fashion or prestige.

A side effect of this oft-repeated experience was to firmly establish systems analysis, and to a lesser extent operations research, as a methodology for making business decisions. As the prestige of systems analysis was fortified by its successes and as, simultaneously, the computer grew in power, the problems tackled by systems analysts became more and more complex, and the computer appeared an ever more suitable instrument to handle great complexity. Normally systems analysis appears, to the casual observer at least, to have been swallowed up by the computer. This appearance is misleading but not without significance. Systems analysis has survived and prospered as a discipline in its own right. The computer has put muscles on its techniques. It has so greatly strengthened them as to make them qualitatively different from their early manual counterparts. The latter, consequently, have largely disappeared. And the computer can no longer be factored out of the former.

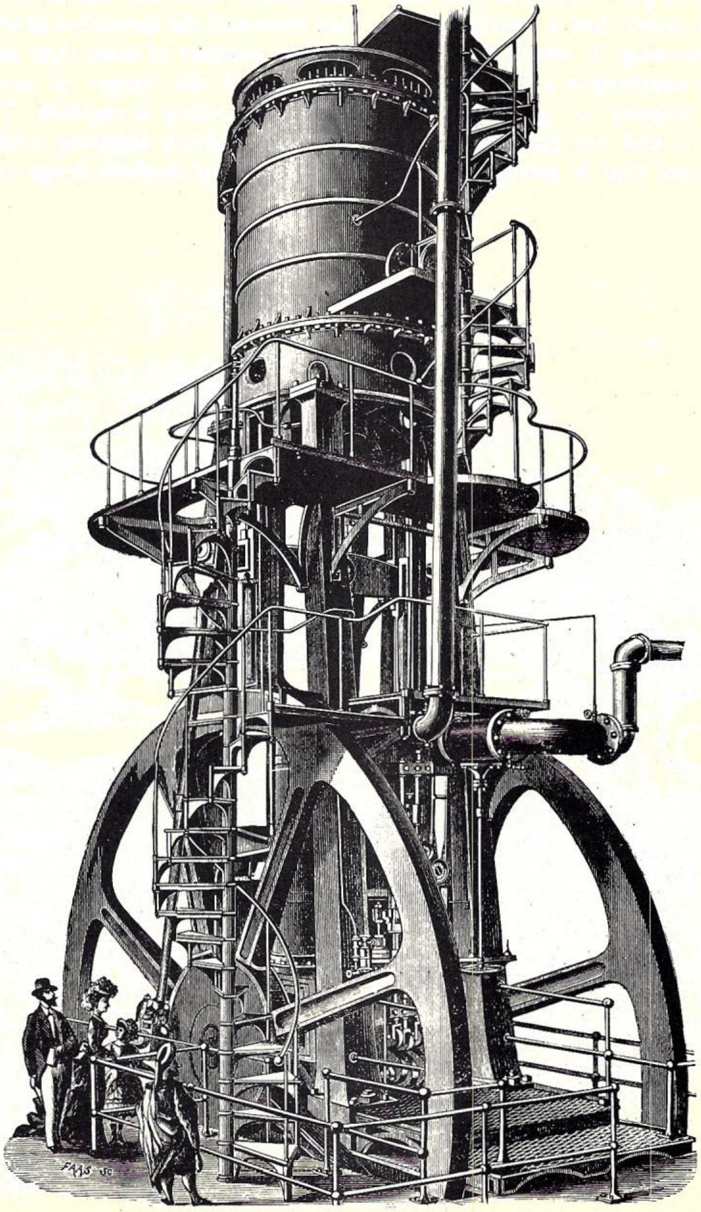
The computer helped pry open the door to outer space. But it also closed certain doors, perhaps irreversibly.

The interaction of the computer with systems analysis is instructive from another point of view as well. It is important to understand very clearly that strengthening a particular technique—putting muscles on it—contributes nothing to its validity. For example, there are computer programs that carry out with great precision all the calculations required to cast the horoscope of an individual whose time and place of birth are known. Because the computer does all the tedious symbol manipulations, they can be done much more quickly and in much more detail than is normally possible for a human astrologer. But such an improvement in the technique of horoscope casting is irrelevant to the validity of astrological forecasting. If astrology is nonsense, then computerized astrology is just as surely nonsense. Now, sometimes certain simple techniques are invalid for the domains to which they are applied merely because of their very simplicity, whereas much more complicated techniques of the

same kind are valid in those domains. That is not true for astrology, but may well be true of, say, numerical weather forecasting. For the latter, the number of data that must be taken into account, and the amount of computation that must be done on them in order to produce an accurate weather forecast, may well be so large that no team of humans, however large, could complete the computations in any reasonable time whatever. And any simplification of the technique sufficient to reduce the computational task to proportions manageable by humans would invalidate the technique itself. In such cases the computer may contribute to making a hitherto impractical technique practical. But what has to be remembered is that the validity of a technique is a question that involves the technique and its subject matter. If a bad idea is to be converted into a good one, the *source* of its weakness must be discovered and repaired. A person falling into a manhole is rarely helped by making it possible for him to fall faster or more efficiently.

It may seem odd, even paradoxical, that the enhancement of a technique may expose its weaknesses and limitations, but it should not surprise us. The capacity of the human mind for sloppy thinking and for rationalizing, for explaining away the consequences of its sloppy thinking, is very large. If a particular technique requires an enormous amount of computation and if only a limited computational effort can be devoted to it, then a failure of the technique can easily be explained away on the ground that, because of computational limitations, it was never really tested. The technique itself is immunized against critical examination by such evasions. Indeed, it may well be fortified, for the belief that an otherwise faultless and probably enormously powerful technique is cramped by some single limitation tends to lead the devotee to put effort into removing that limitation. When this limitation seems to him to be entirely computational, and when a computer is offered to help remove it, he may well launch a program of intensive, time-consuming "research" aimed simply at "computerizing" his technique. Such programs usually generate subproblems of a strictly computational nature that tend, by virtue of their very magnitude, to increasingly dominate the task and, unless great care is taken to avoid it, to eventually become the center of attention. As ever more investment is made in attacking these initially ancillary subproblems, and as progress is made in cracking them, an illusion tends to grow that real work is being done on the main problem. The poverty of the technique, if it is indeed impotent to deal with its presumed subject matter, is thus hidden behind a mountain of effort, much of which may well be successful in its own terms. But these are terms in a constructed context that has no substantive overlap with, or even relationship to, the context determined by the problem to which the original technique is to be applied. The collection of subproblems together with the lore, jargon, and subtechniques which crystalized around them, becomes reified. The larger this collection is, and the more human energy has been invested in its creation, the more real it seems. And the harder the subproblems were to solve and the more technical success was gained in solving them, the more is the original technique fortified.

I have discussed the role that tools play in man's imaginative reconstruction of his world and in the sharpening of his techniques. However, tools play another related role as well: they constitute a kind of language for the society that employs them, a language of social action. Later on I will say more about language. Let it suffice for now to characterize language somewhat incompletely as consisting of a

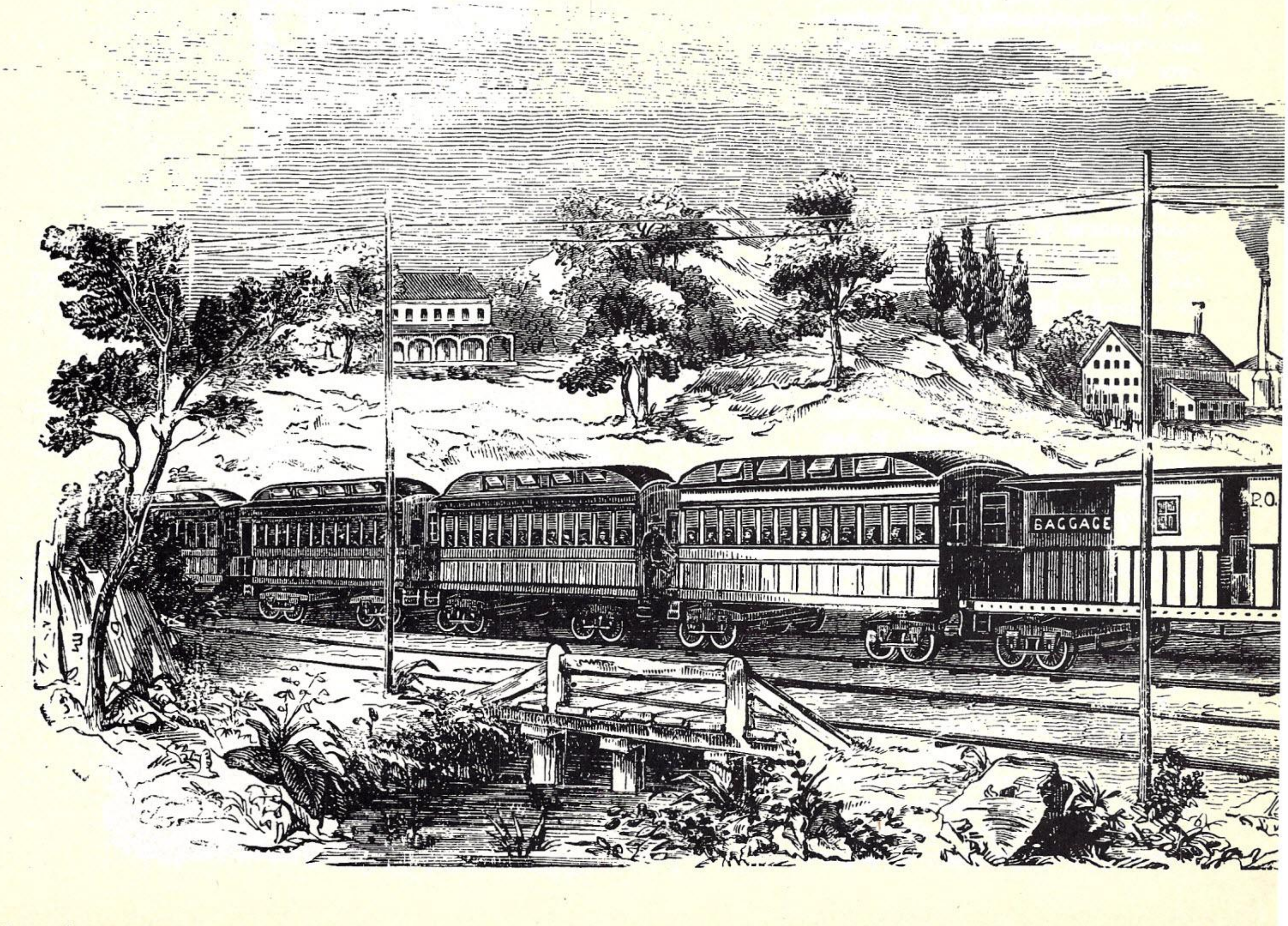


Society's newly created ways to act often eliminate the very possibility of acting in older ways.

vocabulary—the words of the language—and a set of rules that determine how individual vocabulary items may be concatenated to form meaningful sentences. I leave to one side for the moment the innumerable mysteries that surround the concept of meaning. I restrict myself to its narrowest conception, namely, that of the action which a particular "sentence" in the language of tools initiates and accomplishes.

Ordinary language gains its expressive power in part from the fact that each of its words has a restricted domain of meaning. It would be impossible to say anything in a language that consisted entirely of pronouns, for example. A tool too gains its power from the fact that it permits certain actions and not others. For example, a hammer has to be rigid. It can therefore not be used as a rope. There can be no such things as general-purpose tools, just as there can be no general-purpose words. We know that the use of specific words in vastly general ways, for example, such words as "like" and "y'know," impoverishes rather than enriches current American English.

Perhaps it is as difficult to invent truly new tools as it is to invent truly new words. But the twentieth century has witnessed the invention of at least a modest number of tools that do actually extend the range of action of which the society is capable. The automobile and the highway, radio and television, and modern drugs and surgical procedures immediately come to mind. These things have enabled society to articulate patterns of action that were never before possible. What is less often said, however, is that the society's newly created ways to act often eliminate the very possibility of acting in older ways. An analogous thing happens in ordinary language. For example, now that the word "inoperative" has been used by high government officials as a euphemism for the word "lie," it can no longer be used to communicate its earlier meaning. Terms like "free" (as in "the free world"), "final solution," "defense," and "aggression" have been so thoroughly debased by corrupt usage that they have become essentially useless for ordinary discourse. Similarly, a highway permits people to travel between the geographical centers it connects, but, because of the side effects that it and other factors synergistically engender, it imprisons poor people in inner cities as effectively as if the cities were walled in. The mass-communication media are sometimes

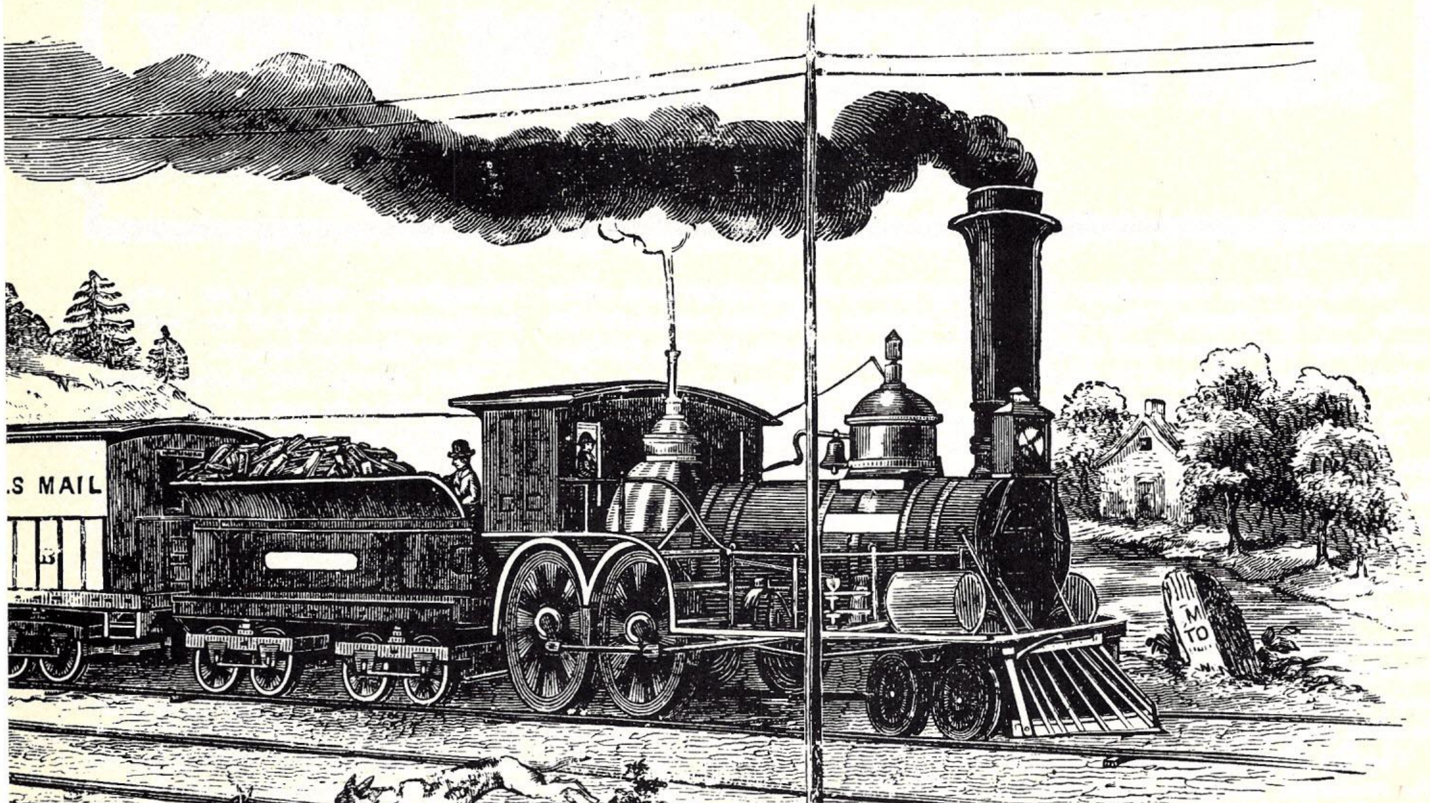


The picture of management typing "What shall we do now?" into their computers and waiting for a decision is wrong.

said to have reduced the earth to a global village and to have enabled national and even global town meetings. But, in contrast to the traditional New England town meeting which was—and remains so in my home town—an exercise in *participatory* politics, the mass media permit essentially no talking back. Like highways and automobiles, they enable the society to articulate entirely new forms of social action, but at the same time they irreversibly disable formerly available modes of social behavior.

The computer is, in a sense, a tool of this kind. It helped pry open the door to outer space, and it saved certain societal institutions that were threatened with collapse under the weight of a rapidly growing population. But its impact has also closed certain doors that were once open . . . whether irreversibly or not, we cannot say with certainty. There is a myth that computers are today making important decisions of the kind that were earlier made by people. Perhaps there are isolated examples of that here and there in our society. But the widely believed picture of managers typing questions of the form "What shall we do now?" into their computers and then waiting for their computers to "decide" is largely wrong. What is happening instead is that people have turned the processing of information on which decisions must be based over to enormously complex computer systems. They have, with few exceptions, reserved for themselves the right to make decisions based on the outcome of such computing processes. People are thus able to maintain the illusion, and it is often just that, that they are after all the decisionmakers. But, as we shall argue, a computing system that permits the asking of only certain kinds of questions, that accepts only certain kinds of "data," and that cannot even in principle be understood by those who rely on it, such a computing system has effectively closed many doors that were open before it was installed.

In order to understand how the computer attained so very much power, both as an actor and as a force on the human imagination, we must first discuss where the power of the computer comes from and how the computer does what it does. That is what we shall turn our attention to in the next issue with "Computer Power and Where It Comes From." ▼



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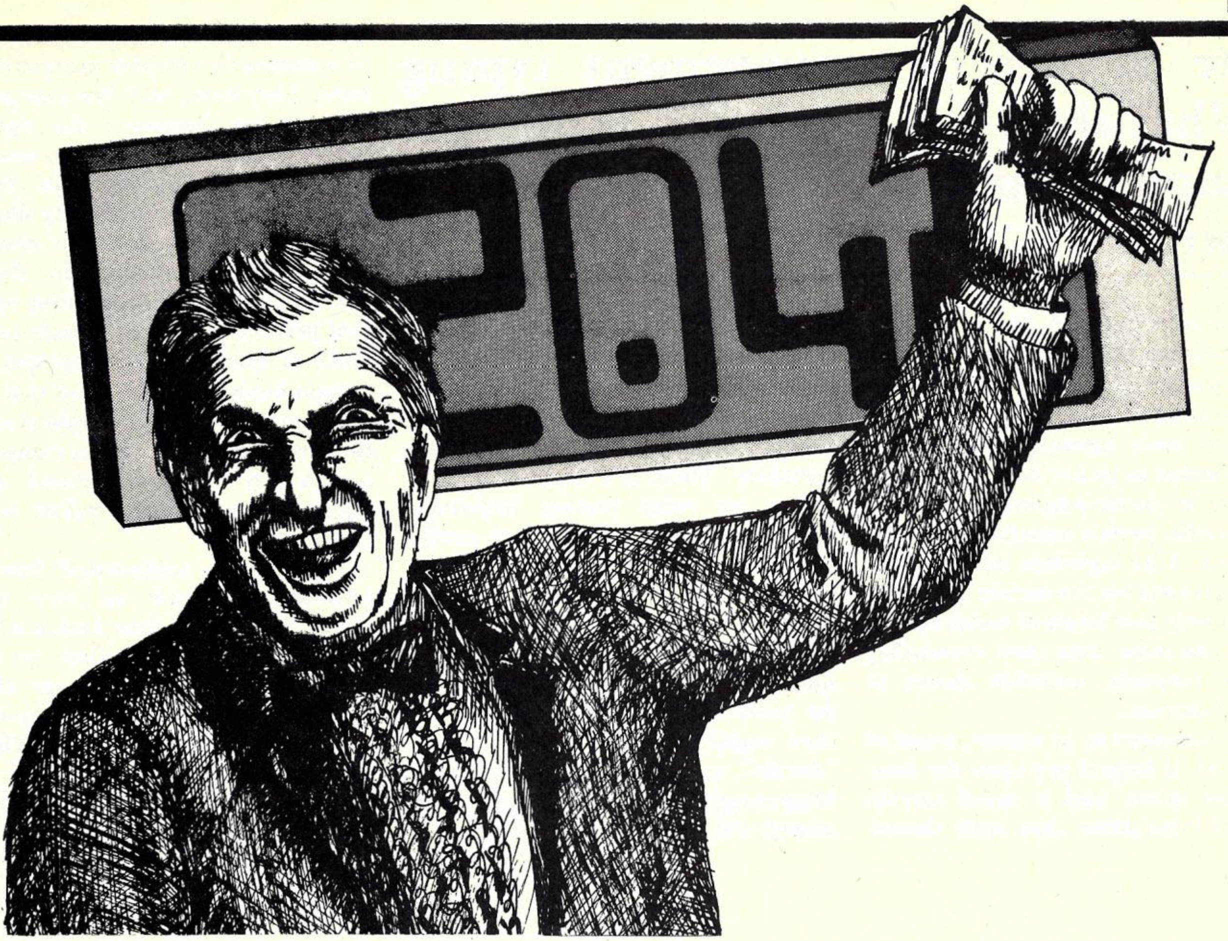


ANYONE CAN WIN

by Thorn Veblen

"We're off to a tremendous start, ladies and gentlemen. The elapsed time is only twelve hours and fourteen minutes and already it's 212. Correction, the Big Board now says 214."

The crowd in the packed auditorium murmured like a hive of wasps. Excitement was everywhere. The television cameras panned slowly back and forth over the well-dressed and elite audience to give the home viewers a good idea of the celebrities present and the excitement that filled those lucky few who had been able to gain admittance to the main studio during the Summer Festival.

The Big Board, a grey mausoleum-like structure, occupied most of the stage. Beneath it, on a small catwalk platform, stood the announcers and their staff. The board itself had one huge slot in the top center from which the number shone out constantly like the bright, radiating eye of a Cyclops.

"That was a big one!" the announcer exclaimed with joy. "The number jumped from 216 to 223. A total gain of seven points." He turned to one of his assistants. "Did you see where that seven came from, Jack?"

"Yes, Henry, I believe it was California. Incidentally, you'll notice that California is already far ahead in the lead with a state total of forty-eight."

"That's right, Jack. You can see it for yourself, folks," the announcer continued, pointing to one of the smaller slots, labeled California, beneath the big long slot which now contained "236" on the large red LCD readout. "The runner-up seems to be Pennsylvania, with a state total of twenty-seven. But we're far from the end. Anything can happen."

"Well, Henry," the assistant interrupted, "what do you say we turn to our ACCIVAC and see what the odds are right now."

"Good idea, Jack. Will one of our charming young Bump Girls run over to the other side of the stage and get a quote?"

A tall slender young thing of about twenty, who was more out of than in her low cut, chromed Bump Suit, stood up and began to walk away from the center stage table. The television camera focused on her firmly dentured smile, engendering that wholesome image desired by everyone connected with the production. Then, to give the adult viewers a little more, the camera followed down her chin past the well-exposed cleavage, turned quickly at about the navel, and gave a last teasing view of the high-cut silk over the thighs and the wriggly derriere as the Bump Girl danced her way over to the ACCIVAC, accompanied by one of the latest rock tunes, to get the quote.

"Isn't she lovely, folks," said the announcer, lapsing into a slightly lecherous smile as the camera zoomed in on her hand reaching toward the clicking computer. Everyone in the audience clapped as she coyly pulled the white sheet from the machine and brought it back to the announcer.

"And here it is. The odds are still way up there, folks. Anyone betting now still gets sixty-five to one. And listen to this, the total pool so far is a record-breaking $18,342,210."

A silent hush ran through the audience.

"Remember, folks," continued the announcer, "and how could you forget, this is tax-free money. Nothing like it anywhere else in the whole world. And now for you people interested in the smaller state pools, let's go to studio three in Washington and get the run-down. Take her away, John Beaty."

"Thank you, Henry. Here we are with the state breakdowns. Alabama this year has a good-size pool with an up-to-the-minute total of $342,212 going at the above-average odds of eighty-three to one. On to our next state pool. . . ." and while the Washington announcer went through each state in order, the audience in the main New York studio filtered out to have dinner and stretch their legs. Some of them went to the betting windows and placed small cover wagers. Most of the New York audience was composed of heavy gamblers, and so they had taken advantage of the higher odds early in the game to place their bets.

At home, the television audiences got up from their chairs to get another beer, go to the bathroom, or raid the icebox. Several thousand husbands took the opportunity to sneak out and place an additional wager at the corner government betting terminal, while their mildly disapproving wives were too occupied with culinary objectives to protest.

"And that about wraps up the state pools down here in Washington."

"Thank you John for that detailed up-to-the-minute count on the state pools." He continued through a subdued yawn, "It certainly is exciting to get an exact breakdown of the total score. By the way, John, how's the weather down there?"

"Sunny and clear, Henry. How about New York?"

"Well, John, it's a little foggy here tonight. And that means, ladies and gentlemen, that perhaps we should turn to our lovely weather girl to get an accurate state-by-state picture of the weather. For those of you still betting, this could be crucial. Take it away, June Sunshine."

Several thousand husbands took the opportunity to sneak out.

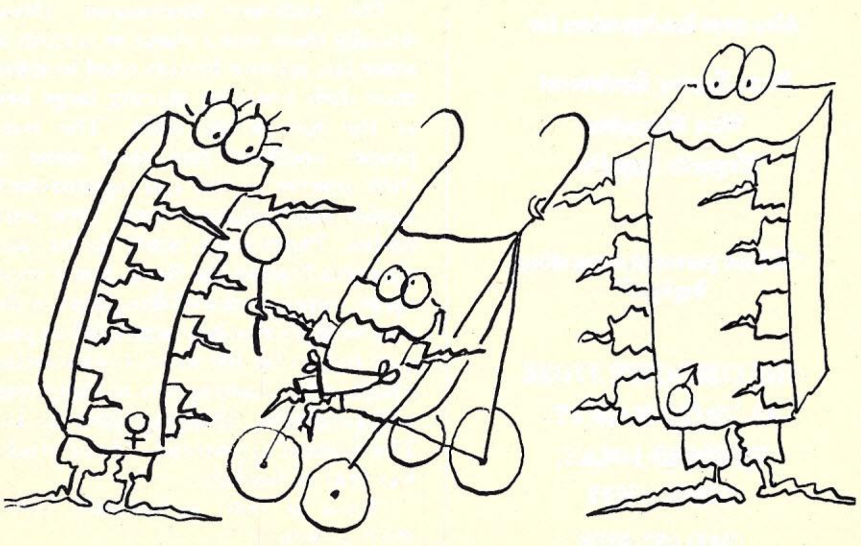
"Hello there, friends," June's voice drooled out in counter-point to the "weather music" played with her introduction. "It certainly is exciting this year, isn't it? By the way, Henry, you didn't give us the latest up-to-the-minute total. How are we doing now?"

"Glad you asked, June." He was almost visibly frowning at his oversight. "According to the board, after almost thirty-six hours it now stands at 863. And the total pool according to ACCIVAC. . . ." He patted one of the Bump Girls on her posterior and sent her off in the direction of the computer. "We'll have that for you in just a minute, folks. Meanwhile it might interest you to know that the 863 figure puts us a fantastic 61 ahead of last year. Looks like we're going to have a real record-breaker this time. Keep that in mind when you bet. And here she is, folks," he smiled at the Bump Girl who was having considerable problems keeping her outfit on as she returned.

The announcer took the sheet from her hand. "I say, folks, isn't she lovely." He bent down and gave her an embracing kiss. Then, still clutching her, he read from the sheet. "Wow! You won't believe it. The odds are still way up there, fifty-two to one. And the total pool. Get this! $65,632,290. Utterly fantastic. We're breaking every known record. And now for those of you that still want to take advantage of this fantastic opportunity, let's go back to June Sunshine and give you some accurate information to work with. June?"

"Thank you once more, Henry. And here we go." A blare of trumpets preceded her next speech. "Alabama is having thundershowers right now,

EVE ' N ' PARITY



"Sure looks like a chip off the old block."

Korkie

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which might help explain the heavy betting down there. And incidentally, before I go on, here is a bulletin. Heavy smog is plaguing the whole stretch between Los Angeles and San Francisco. You see, viewers over in London, you aren't the only foggy ones." She tittered and then continued. "Here are the rest of the states in order . . . ."

The odds are still way up there, fifty-two to one. And the total pool. Get this! $65,632,290.

Once more the New York audience left their seats. This time some of them went home or to a hotel to try and grab a quick catnap. Those who were viewing the spectacular at home or at "crash parties" were already exhausted and asleep in their chairs.

The televisions blared on, but with a new announcer. Henry had twelve hours off in which to freshen up and rest.

And so it went, exciting announcements followed exciting events until almost three days had elapsed and there were only minutes left until the end. The audience's beloved Henry was once more back at his post under the Cyclops' eye.

"This is absolutely fantastic. If I hadn't seen it with my own eyes I'd never have believed it. Look at that, folks." He pointed to the number which was by now 1,932.

The audience murmured. Occasionally there was a shout or scream as some last minute bettors tried to minimize their losses by placing large bets at the now lower odds. The once proper audience had shed some of their reserve as the end approached. Ladies had removed shoes, men went hatless. Paper cups, score sheets, and tip cards littered the floor. Some teenagers, mostly sons and daughters of the very wealthy who had managed to procure tickets for the main broadcasting studio, were slashing idly at their seats with penknives. Shouting filled the air. The general appearance of the studio was that of bedlam.

"Look at that, a fantastic 1,932. Wait a minute."

The numbers changed.

"I don't believe it. It's jumped to 1,985. That's an increase of 53. The biggest jump I've ever seen in my twelve years of covering this tremendous event. Where did that 53 come from, Bill?"

"Well, Henry, you won't believe it but Hawaii did that."

"Hawaii!"

"That's right, Henry. And we've got an on-the-spot helicopter which should be at the scene in a couple of minutes."

"Great coverage, Bill. Hope we make it. There's only twelve minutes left. In fact, folks, I think I'd better walk right over to ACCIVAC with our Bump Girls and get ready for the countdown." He gave an arm to each of two girls who stood next to him.

"Look at that, folks—1,996. There's no doubt about it, this is going to be a record-breaker. Over 2,000. I'm willing to bet on it." The whole audience laughed with him as he chuckled at his own joke.

They were over by the computer now. Tremendous suspense music flowed through the studio. Then suddenly air raid signals filled the air, drowning out all other sounds. Everyone in the audience stood up.

"That's the signal, ladies and gentlemen. The final odds are 6.31 to 1. That's a record high pay-out, folks. Watch the number, it's 2,002 now. There's a $163,025,950 pool riding on it now. That's the total. All betting is closed. There goes the number again—2,004. Is that your number, friend? Are you going to take it home tonight? Look at that jump—2,025. That's 21 in one jump. This is fantastic! I've never seen anything like it. 2,028 and thirty seconds to go. 2,032, 2,033, 2,041."

There was a wild blinking of lights. Air raid sirens again filled the air. When the noise quieted down Henry shouted over the rapidly dissipating audience.

"Well, that's it, folks. All you lucky winners with number 2,041 can go and collect. That's our grand total this glorious Fourth of July Weekend. 2,041 traffic fatalities." ▼

Logo © 1977 by Computer Faire

THE FIRST WEST COAST COMPUTER FAIRE

A Conference & Exposition on Personal & Home Computers

by Elizabeth Fairchild

From the second floor balcony the main exhibition hall was a seething mass of people divided into six rows by yellow curtains. Four large green and yellow balloons floated serenely above the crowd. Several competing computerized melodies drifted up with the general din.

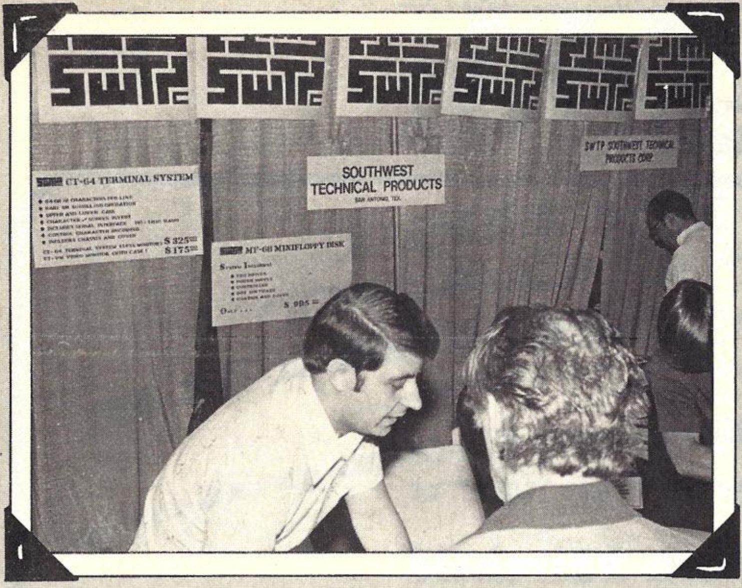
But it was impossible to stay long in the balcony because time was short and I didn't want to miss anything. The excitement was down on the floor among the exhibits themselves. I had an impossible desire—to see and understand everything. The West Coast Computer Faire was under way with at least one amazed novice on board.

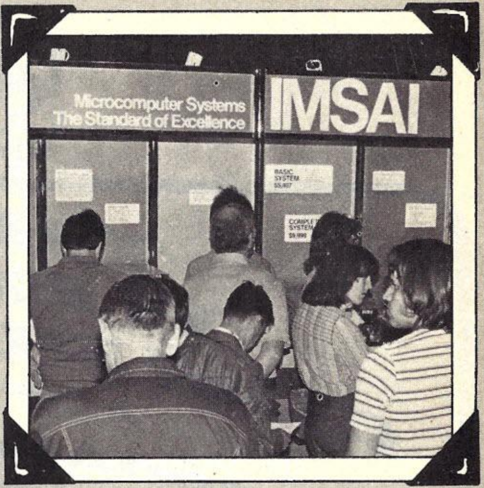
One booth had a computer that talked, and another had a computer that listened. All around me people spoke a foreign language only vaguely resembling English. In a huge maze of an auditorium, thousands of milling people were united by a desire to see and experience, to be amazed, to be entertained and fascinated.

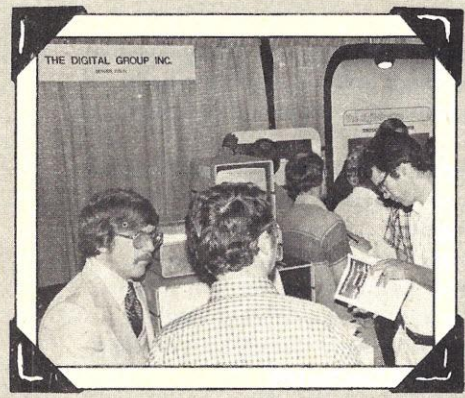
The main impetus for the Faire came from Jim Warren, editor of *dr. dobb's journal of Computer Calisthenics & Orthodontia* and self-proclaimed "Chairbeing." The Homebrew Club of the Bay Area, a loose collection of computer hobbyists who meet on alternate Wednesdays, supported and sponsored the project along with such staid organizations as the Stanford University Department of Electrical Engineering and the Association for Computing Machinery. As Jim Warren described it, "This was a homebrew convention. Everyone involved was strictly an amateur. Consequently, it had its glitches, but ninety-five percent of the people here were as excited as I am about this hobby and the new consumer market it has opened up. I call it 'Computer Power for the People.'"

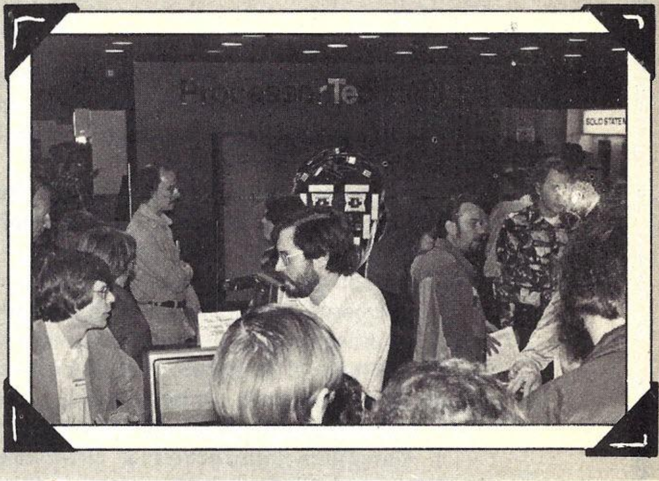
12,755 people came to the Faire in San Francisco, including a tour group from Japan and people from England, West Germany, and Australia—the biggest home computing convention ever put together.

Dealers attended from all over. Charles Suit of the Computer Systems Store in McLean, Virginia, said he came to the Faire because "I am starting up a store and the Faire is a good place to meet all the vendors." He was concerned about the fact that virtually all manufacturers of home-computing equipment are small companies. "With a big company you know what to expect in terms of deliveries and company stability." Nonetheless, he is excited about the potential market. "High school students in my area who are into math generally know BASIC. We expect to see parents buying $400-$500 kits for their teenage children." Personally, he is interested in computer communication networks between people (a seminar topic at the Faire). He'd also like






THE DIGITAL GROUP INC.



a terminal linked to F.A.A. weather reports. "As a pilot, I would like an instant weather report for any location."

Most people at the Faire appeared to have some previous knowledge about computers—from working with one, owning one, or hoping to own one. All the technical jargon was very much a new language to me; I call it Computerese. Two weeks before the Faire, I knew nothing about computers. But a new job with Processor Technology led to my helping out in a booth, so there I was at the biggest Faire yet.

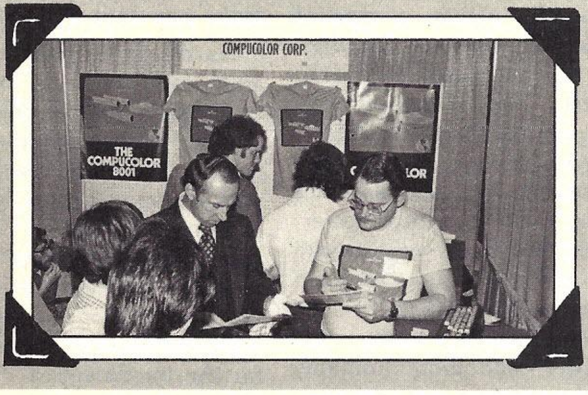
There was a mob of little Captain Kirks trying to get the hang of Star Trek.

The presence of hordes of kids surprised me; even more surprising, they were having a good time. In fact, to get at any of the video games at the Processor Technology booth, adults had to elbow through a mob of little Captain Kirks trying to get the hang of *Star Trek*. This game, by the way, is not easy; the instruction manual runs over five pages, but the kids were figuring it out themselves. One dedicated teenager stood for five solid hours with his eyes on the screen, either playing or teaching others what he had figured out.

Computer Billiards looked like fun, but who could get near the machine? To get your ball in the pocket involved timing as well as aim, because the direction in which the cue ball would move changed from moment to moment. *Target* is another game of skill played against the computer. Fortunately, the player can select the level of difficulty before the game starts, thereby giving the beginners a fighting chance. The idea is to shoot down airplanes, missiles, and parachutists who come flying by at varying speeds from both directions, sometimes several at once. You lose points for every one that gets by and for every missed shot. This game has a universal appeal because the rules are simple but the execution is not, and intense concentration is required.

A prim eight-year-old girl was having fun at the Recreational Computing booth learning how to draw in colors on a TV screen. Keyboard codes controlled the color of the line and the direction it moved. She was completely

PolyMorphic Systems



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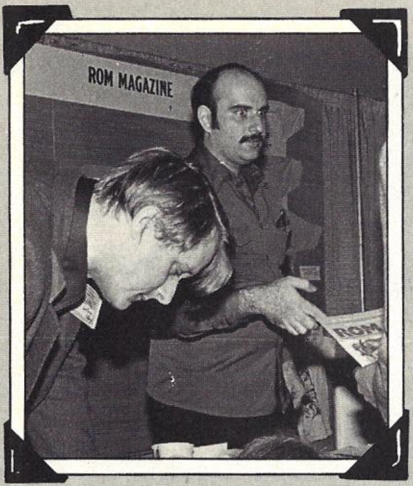
absorbed in trying to control the picture. Mothers who worry that their impressionable children have become addicted to the passive medium of television may see some hope in computer games and entertainments which take a child's well-developed fascination with the screen and turn it to educational or at least active pursuits.

Six-year-old Randall also thought the Faire was "Good." He was too young to play the games but his favorite exhibits were the music show and "the red and yellow light show over there." "Over there" was Apple Computer's video graphics display on a giant Advent monitor. The picture moved and changed colors constantly. Lots of people (including me) liked the graphics at the show. My personal favorite in this area was a polymorphous laser beam video show with music that was part of a Computer Art Systems seminar. It was not on sale with the other hardware, but there's always next year.

Looking for fun and diversion, I got my personal biorhythm charted at the IMSAI booth and learned my projected physical, mental, and emotional ups and downs for the next thirty days. Wizard Eye Studio put my face on a printout sheet for free in about one minute. At the Midwest Scientific booth, a magic wand picked up bar codes when rubbed across a printed page and transmitted them directly to a computer.

My personal favorite was a polymorphous laser beam video show with music.

"Music and Computers" was another big topic for seminar sessions. However, the technology displayed at the booths was disappointing. Strains of "It's a Small World," a la Disneyland, played tirelessly ad nauseam. Even with occasional bouncing Bach I was left unmoved. The monotony was a consequence of no variation whatsoever in volume or tempo, producing a melody with no emotional tone. But the potential is there. One software developer has grand ideas for programs to play music in different styles—just push the baroque button. Also, the computer can easily produce results that would be difficult if not impossible for a human, such as making a sound appear to move in a



MICROCOMPUTER SYSTEMS
Midwest Scientific Instruments
MICROCOMPUTER PRODUCTS

TECHNICAL DESIGN LABS
Z80
XITAN

particular eccentric pattern around the room (given a quadraphonic sound system, of course).

One of the most popular musical computers on the exhibit floor belonged to ALF Products. The system combined a pleasing tone with an absorbing video display of notes and a fortuitous selection of Scott Joplin rags. The music was still one-dimensional, but more pleasing. They claimed the secret of their success was a "clean sound" with no clicks or rasps; or maybe they just picked music I like. Anyway, people were always around their booth. Rick Harmon of ALF told me: "It's been great but tiring standing up for nine hours a day with crowds around all the time." Phil Tubb added that they decided to come to the convention only at the last minute, when a friend offered them a corner of his booth. "We wrote all the software for this demo in two days and then drove from Colorado."

A big first for this home computing convention and, in fact, for any computer conference, was the high level of interest in the possibilities computers offer the physically disabled. Many handicapped persons attended, and it wasn't difficult to understand why. Blind persons can now "read" the newspaper directly by scanning the print with a unit that sends signals to the computer which are then translated into a vibration pattern the blind person can feel. With a computer speech synthesizer, a deaf mute can now begin to "talk." Another extremely valuable development is the electromyographic switch, a type of electrode that picks up nerve impulses through the skin and passes a signal to the computer. The computer can consult its program to take action—turn the pages of a book, dial the telephone, or scratch my left shoulder blade, please, that's it, a little lower, and a bit left. For many people who find simple tasks a major problem from day to day, the potential of the personal computer to make life brighter, easier, and more humanly satisfying is immediate and very real.

Earlier, I had a long argument with an electronic engineer who claims that computers can do anything that humans can do, it's just a matter of developing the technology. I claimed he was wrong. Humans are better. I need to believe that I am something no machine can duplicate.

As Horace Enea of Heuristics told me, "Most of our customers want to do something significant with their computers." I'd like to see my engineer friend develop a computer that wants to do something significant with another machine. The fact is, computers don't care. They have no feelings. People *do* care, and the capabilities of the computer tend to bring this out.

After all, how many people want to do something significant with a stereo set? There is some very essential difference between home computers and the other advanced technological gear that has entered people's homes. TVs encourage passivity. Computers make you want to do something.

Hardware to make computers talk and/or listen also got lots of attention. One booth had a talking computer that recited the alphabet and counted to ten. The result was very crisp and well enunciated, and not so eerie as I expected. Most of the attention centered on Heuristics' Speechlab system. The $249 kit provides vocal input to any S-100 bus computer for any use from computer games to vocal control for the handicapped. "Open sesame" can now be the password to open your door, and you don't have to be as rich as the Sultan or as clever as Scheherazade to do it.

Horace Enea of Heuristics said that the Speechlab will accept spoken commands in BASIC and has the potential for much faster input than typing on a keyboard. (The average person can talk at 120 words per minute.) He found the response to his product overwhelming. "We saw many more people than we expected and went from being stocked to being back-ordered during the weekend."

Suddenly it was closing time. Jim Warren announced the attendance total over the PA system in a jubilant tone, followed by Ted Nelson who said, "This is Captain Kirk, prepare for blastoff." An exhausted Bob Marsh, Processor Technology's Vice President, was asked how he felt about the response to his exhibit. All he could say was "Super." ▼

SPACE, ORDER, AND GOOD SOLDERING

by Ed Hershberger

No one really wants to read all that technical jargon or arrange a lot of little parts at first. But having your own computer means that you should know what is going on with it—and keep learning. Besides, some day you'll probably want to build a peripheral or other kit from scratch—just out of curiosity. Speaking not as a veteran but rather as someone who is definitely about waist-deep in diodes, transformers, and color-coded wire, I suggest you cut your losses and frustrating moments.

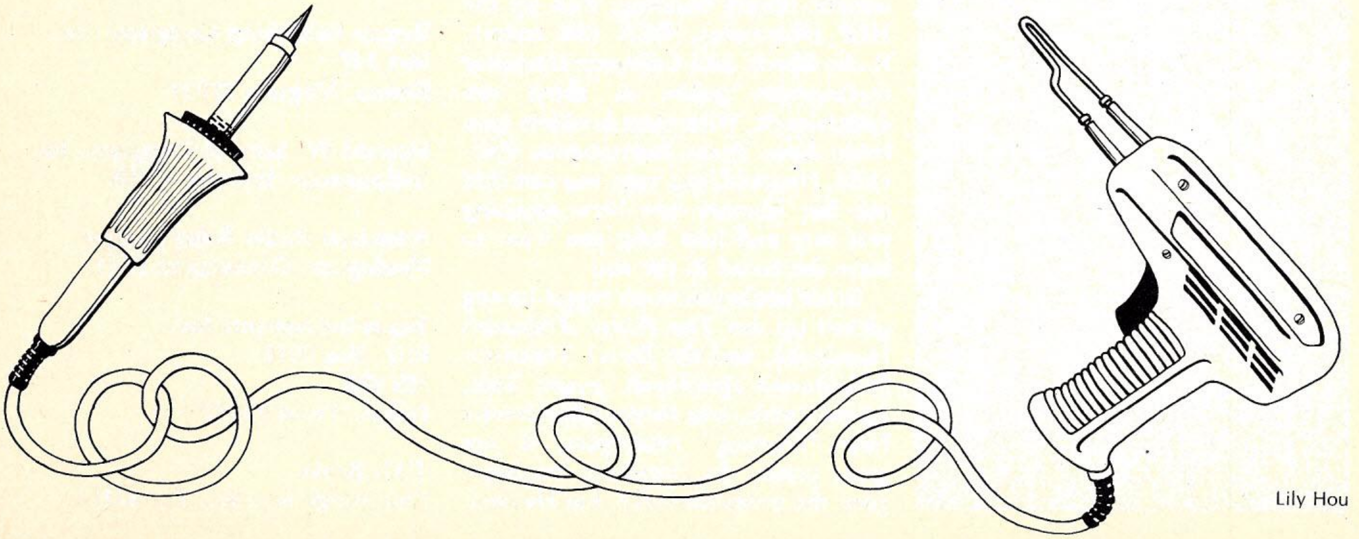
Start with *a place*. That is, try to get your own space for soldering and trouble shooting. If not everybody in the house is interested in your computer fever, you will be happy to be able to answer the phone without returning to a memory board covered with lasagna or laundry. Try to negotiate bench space where your half-finished projects can be left undisturbed until you can get back to them. Kitchen tables are all right if you make sure you can pack up and store the project by the next meal time.

You will be happy to be able to answer the phone without returning to a memory board covered with lasagna or laundry.

So, what equipment do you need in order to build a kit? Start with a vise, a good soldering iron (twenty-five-watt, three-wire, or grounded-tip), needle-nose, straight, and bent pliers, a bench, and a from-over-the-shoulder light. From there you can expand. A volt-ohm meter, a power supply of five and fifteen volts/DC, integrated circuit insertion tools, and solder-suckers would be good things to build or acquire, as well as your favorites in wire cutters, strippers, and a good magnifier (hood or stand type). After you do a few kits on a small scale (may I suggest time-of-day clock kits or small Heathkits), you'll know what tools you prefer.

You don't have to spend all the beer money on a shop. But if it comes to justifying it to the rest of the family, remember to mention that your computer is likely to be of great convenience and educational value. Mention the kitchen (recipes, food inventory, diet planning), garage (car-maintenance records, function diagnosis), and family finances (bills due, checkbook balancing) as possible beneficiaries. Kids may enjoy graphics capabilities; teenagers can find out whether they want to get into the data-processing/auto-control craziness before they decide to become programmers. In short, explain that you're making a tool with more possibilities than it looks like at first.

Next, a breadboard set-up is no waste for the serious builder of kits and designer of electronic tools. You will soon learn to breadboard, test, modify, and solder-up. By then, you may even have substitution boxes for capacitors and resistors, and an oscilloscope—but you'll certainly have a lot



Lily Hou

ROMtutorial ROMtutorial

Memory board: *A printed-circuit board designed to hold information in an electronic memory. The board plugs into a slot in the computer which can use the board as a place to read and store information in the form of electronic signals.*

Breadboard: *In the very old days, electronics enthusiasts would actually use a breadboard on which to build their radios. Nowadays, it means any temporary electronic assembly meant to allow easy changing of connections.*

Integrated circuit: *A transistor (not the radio) is a tiny speck of specially-processed silicon having three different layers. Integrated circuits contain hundreds or thousands of transistors formed in the same block of silicon, along with the necessary interconnections. The block is still quite small, so it's called a chip, and is often packaged in an inch-long block of plastic with metal connecting pins coming out. Often this package itself is called the chip.*

Get containerized for sanity, and learn to solder for conductivity.

of spare parts too.

Electronics itself is too expensive to be believed if you throw out everything not useful at the moment. So save things. But what you find is that you have to get things in order from the start. Those plastic see-through cabinets of drawers are good for little things (transistors, resistors, capacitors, and chips). A series of similarly classified containers are good for knobs, dials, boards, transformers, and big capacitors. Coffee cans (honey jars in our house), frozen food containers, and cigar boxes are good for this.

Last, learn to solder correctly. You won't be sorry for the time spent in learning to solder well. *The* book on soldering is *Soldering Electrical Connections, A Handbook* obtainable from NASA, U.S. Government Printing Office, Code UT, Washington, D.C. 20546, or at your General Services Administration Bookstore, for thirty-five cents. These NASA guys put proof of their soldering on the moon. The micro-photographs of cold joints may sit in your memory and cause you to develop good soldering habits. Even if you're going to buy your 8080 or 6800 Processor all assembled, you should still know how to fix minor things; in electronics, learning to solder is like learning to drive.

So—you have a place, you're learning to solder, and reading everything you can find about what you understand as computers. Now try some systematic library building. Pick up the HEP (Motorola), RCA (SK series), Radio Shack, and Lafayette transistor replacement guides at about two dollars each. With these booklets (you could have Texas Instruments, Fairchild, National, etc. too) you can find out fast whether you blew anything real rare and how long you want to leave the board in the vise.

Other books you won't regret having picked up are *The Radio Amateur's Handbook*, and the *Direct Transistor Substitution Handbook*. Jensen Tool, Allied Radio, and Newark Electronics have "learning" catalogues, if not great prices. As electronic hardware goes, the publishers vary, but Hayden, Sams, and TAB books are useful if tried on like a suit. A wall chart of resistor values, capacitor values, and transistor lead locations is in a looseleaf book by Calectro called *Calectro Handbook*. And a Heathkit instruction book called *Kitbuilder's Guide* has a good color chart of resistors.

In sum: start now to negotiate for the physical space in your life, get containerized for sanity, and learn to solder for conductivity. Have a good time! ▼

List of Suggested References

Allied Electronics
Division of Tandy Corporation
401 East 8th Street
Fort Worth, Texas 76102

Calectro Handbook
GC Electronics
Division of Hydrometals, Inc.
Rockford, Illinois 61101

Hayden Book Company, Inc.
Rochelle Park, New Jersey 07662

Heath Company
Benton Harbor, Michigan 49022

Jensen Tools and Alloys
4117 N. 44th Street
Phoenix, Arizona 85018

Lafayette Radio Electronics
111 Jericho Turnpike
Syosset, New York 11791

Reston Publishing Company, Inc.
Box 547
Reston, Virginia 22090

Howard W. Sams & Company, Inc.
Indianapolis, Indiana 46268

American Radio Relay League
Newington, Connecticut 06111

Texas Instruments Inc.
P.O. Box 5012
MS 308
Dallas, Texas 75222

TAB Books
Blue Ridge Summit, Pa. 17214

report from

DREADCO

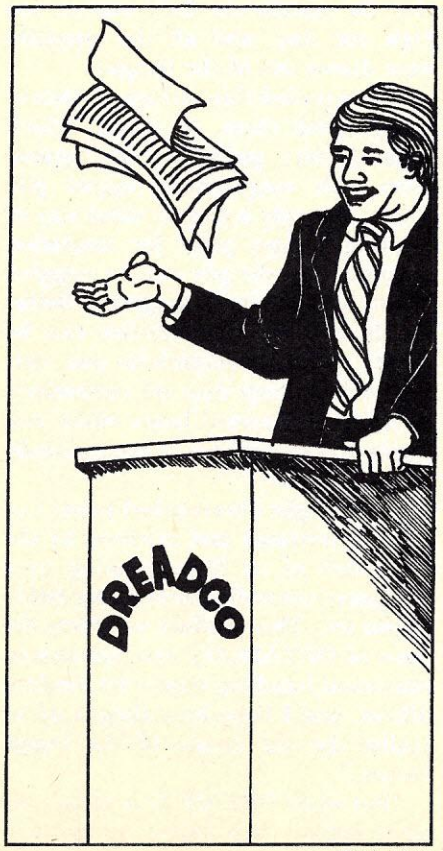
***ROM* was only in its formative stages during the great DREADCO exhibition in the fall of last year, so we were unable to dispatch our British correspondent to it. However, the glorious event was ably recorded by the tolerant staff of *The New Scientist* and we are grateful for the permission to run their courageous coverage.**

"Good afternoon, ladies and gentlemen" began Daedalus from his raised dais, reading from a set of notes apparently suspended in mid-air in front of him. "Welcome to DREADCO House and our little exercise in public relations. We in DREADCO are aware of the dislike which science and technology arouse these days, although our problems are slight compared to those of our colleagues at Grimbledon Down. Today you should see that the picture is not all black."

He paused for a moment while the first page of his buoyant notes turned itself over. "DREADCO is no Flixborough or Seveso," he continued, "but I admit we've had our troubles. Nobody regrets more than I the accidental spillage of our self-spreading surfactant paint, which escaped under the perimeter fence to paint much of the adjoining housing estate magenta-blue.

"Our experimental 11-Hz ultra-low-frequency transmitter did indeed give everybody disturbingly erotic dreams until we realised it was beating with their sleeping brain alpha-rhythms; but we immediately changed the frequency, and now issue free aluminium night caps when we are forced to test that waveband for nocturnal propagation. And we have met in full all compensation claims for bathroom electrocution which arose from an inexperienced technician's pouring highly charged single-ion solutions down a steel sink and into the local metal-piping drainage system.

"On the other side of the coin, the neighbourhood has enjoyed much brighter weather since our Everglo gas started leaking from the pilot plant, turning the sun's ultra-violet radiation into extra visible light. And I confidently attribute the particularly lush vegetation of the district, and the decreased nuisance from rats and mice, to the seismic backscatter from our ultrasonic well-drilling programme, which stimulates nutrient diffusion to plant roots while numbing the rodents' feet.



Cindy Hain

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Cindy Hain

"But such unforeseen interactions with our environment are an unavoidable consequence of the richness and unpredictability of research. And I believe that, here at DREADCO, we have accepted this fact more completely than our rivals. I could tell you of well-organised laboratories where the appearance of an actual new invention spreads a quiet horror among the administrative staff. It threatens them with novelty, change, worrying problems with no administrative precedent—and everybody breathes a secret sigh of relief when the evaluation committee decides that, after all, it isn't practicable.

"I'll remind you that the only basic invention that IBM has ever contributed to computing is the disc-store. It was invented by two IBM engineers in their own time, and when the company found out it tried to stop them. By contrast, my research efforts are hardly organised at all. So many important scientific discoveries have been made while looking for something else that I just let my scientists' changing enthusiasms guide them.

"This isn't as mad as it seems—if you don't know what you are doing, random behaviour is statistically the best policy: and no long-range speculative research team can know what it's doing. Furthermore, no rival firm can guess what DREADCO is going to do next—for we don't know ourselves!

"Let me give you some examples. Some while back one of my biochemists wondered why animals excreted nitrogen as urea, instead of gaining energy by 'cracking' it to nitrogen. He decided that the biochemical incentive wasn't great enough, and so began feeding cows with small amounts of high explosives (which of course yield much higher energies on cracking to free nitrogen). Initial experiments showed that the micro-organisms in the cows' stomachs would indeed adapt to metabolising the explosives. So when dynamite turned out rather uneconomic as a cattle-fodder, we decided to culture the micro-organisms separately and develop them as a novel and very humane bacteriological weapon, to turn the enemy's explosives and propellants bad. Ariadne told you of this development on 21 September, 1972. As so often happens, others follow where we lead, and the US army announced a microbiological disposal method for TNT in 1974. We are now returning to our first idea, and are training bacterially loaded bomb-disposal pigs (rather like those French truffle-sniffing pigs) to sniff out bombs and explosive caches, and render them harmless by eating them.

"Another example is our self-supporting paper," said Daedalus, indicating his floating notes, which obligingly turned over a new page for him. "It arose from an accident with a magnetic-tape project. It's a standard trick to pass the tape-web past a powerful magnet while the coating is still wet, to align the magnetic particles. By mistake the field was set too high one day, and all the particles were drawn out of the lacquer.

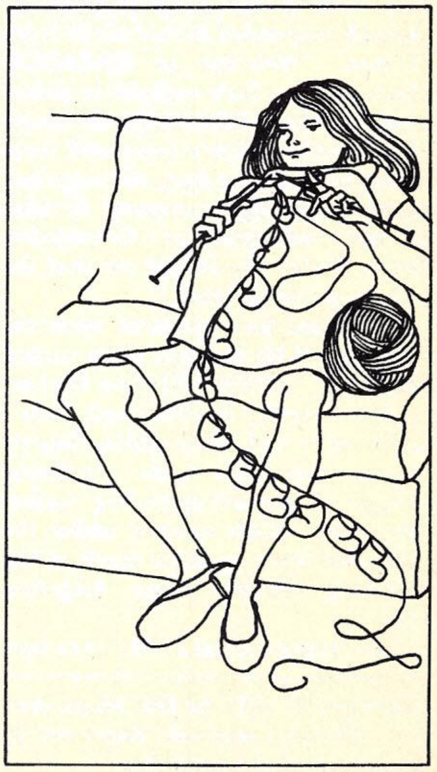
"They pulled thin strings of viscous lacquer with them, of course, which instantly set: giving a furry plastic sheet with magnetically tipped pile fibres. Not only is this an ideal way of creating a furry paint for insulation purposes, but the pile can be waggled about by oscillating magnetic fields. So all sorts of active textiles can be made; shirts that scratch for you, carpets which sweep dust off themselves, even furry-bottomed boats which row themselves on millions of magnetically beating cilia.

"And a light fibre-backed paper can even be levitated and oriented by the downwash of its fibres beating in a computer-controlled alternating field: as you see. This product will form the basis of DREADCO's new automated document handling system for modern offices, and I hope by scaling it up to realise the old dream of the magic carpet."

"But while DREADCO is ideally set up to exploit such happy accidents in this opportunistic and flexible manner, we do have our straightforward successes. I am happy to observe that our continuing programme for the biosynthesis of petroleum hydrocarbons from micro-organisms and more recently from plants (Ariadne: 8 April, 1976) has been taken up by the Nobel prizewinner Melvin Calvin, who in October of this year advocated just this strategy.

"Our natural, organic tranquilliser arose directly from the well-known smug complacency of pregnant women, by isolation of the hormone responsible from the bloodstreams of pregnant volunteers. Being already a human biochemical it has few side-effects—only a slight tendency to derange established dietary preferences and (in high doses) to trigger compulsive bootee-knitting. It is of course the ideal antidote for post-natal depression. And our "hydropogo centipede" vehicle which runs over the ocean on rapidly pedalled plate-like feet, is the straightforward extension of the way a flat stone skips on the water. It has all the advantages of the hovercraft without the atmospheric disturbance, and can also dash up and down steep waves, and walk over smaller craft without mutual damage.

"Well, that's a rough sketch of our philosophy and what we achieve with it. Please feel free to wander around



Cindy Hain

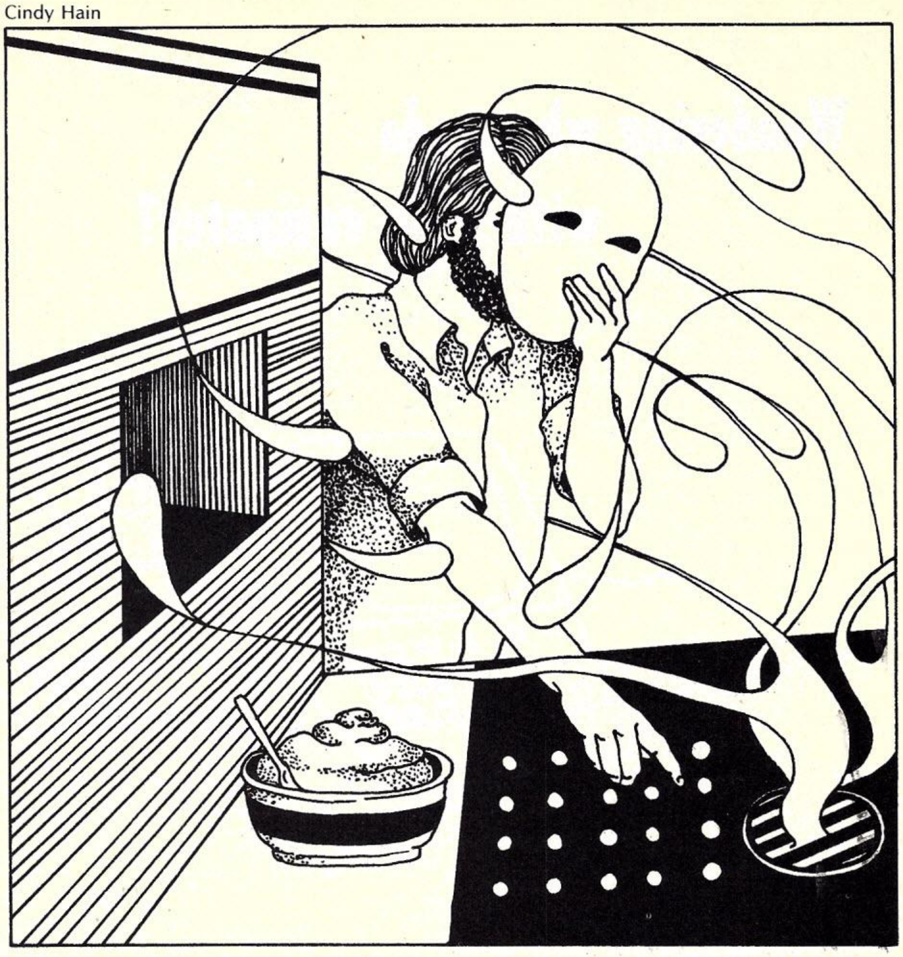
the buffet and the displays in the exhibition hall. I or any of my staff will be happy to answer any queries informally. Thank you."

As the crowd dispersed towards the exhibits, Daedalus and his colleagues mingled with the guests to see how they took it all. The buffet table was soon crowded, and it was amusing to note the reactions to the DREADCO coffee-on-a-stick (a thixotropic jelly which collapsed to a liquid on being masticated), the curried ice-cream (carefully balanced to simulate room temperature) and the "heavy sherry." This isotopic deuterated product is claimed not to contain alcohol as legally defined, and so is free of excise duty. Furthermore, when ordinary "light" alcohol in the bloodstream diffuses into the balancing canals of the inner ears, it reduces the local liquid density and makes you unsteady. This variety has the same density as body fluids, and lets you get plastered without lurching revealingly about. It should do well.

Also offered were samples of DREADCO's protein-fibre hats (for eating) and aversion-therapy sausages for slimmers—piezoelectric devices which administered a painful shock when bitten. But the most discerning guests were clustering round the Universal Pabulum dispenser, which delivered a highly nutritious but entirely tasteless composition. The display notice explained that our sense of "taste" is in fact almost entirely mediated by smell, so by dialling the appropriate choice on one of the facemasks attached to the machine, the appropriate effluvium would be released to simulate whatever delicacy had been requested.

But the buffet was only the entree to a feast of DREADCO ingenuity. Among the smaller exhibits were samples of DREADCO phonon-polymerisation glues (which set when you shout at them) and a new weightless expanded polystyrene, foamed with helium. There were demonstrations of a gyrostabilised helmet which made it almost impossible to fall over, and of an instance-silence aerosol whose droplets dissolve air during sonic compressions and re-evolve it during the rarefactions, thus damping out sound perfectly.

A more complex display invited guests to don an EEG head-set and see their fantasies realised before their eyes on a computer-display driven by signals from the headset. Unknown to them, several slave screens broadcast these private visions for the edification of other guests. Still bolder spirits could enter a tank via an air-lock and experience all the buoyancy and freedom of zero-gravity weightlessness without its disorientation. (The trick was apparently worked by pressurising the tank to 50 atmospheres with a mixture of xenon and oxygen, a breathable gas mixture with the same density as water.) There were film-loops showing blasting with DREADCO's single-crystal TNT (which explodes in one direction only) and trials of the DREADCO "ship of the desert," a porous pressurised craft whose hull pours out enough compressed air to fluidise the sand around it, enabling it to navigate the desert as normal ships do the sea. Altogether, the exhibition gave a powerful impression of the breadth and fecundity of this unique research organisation.


Cindy Hain

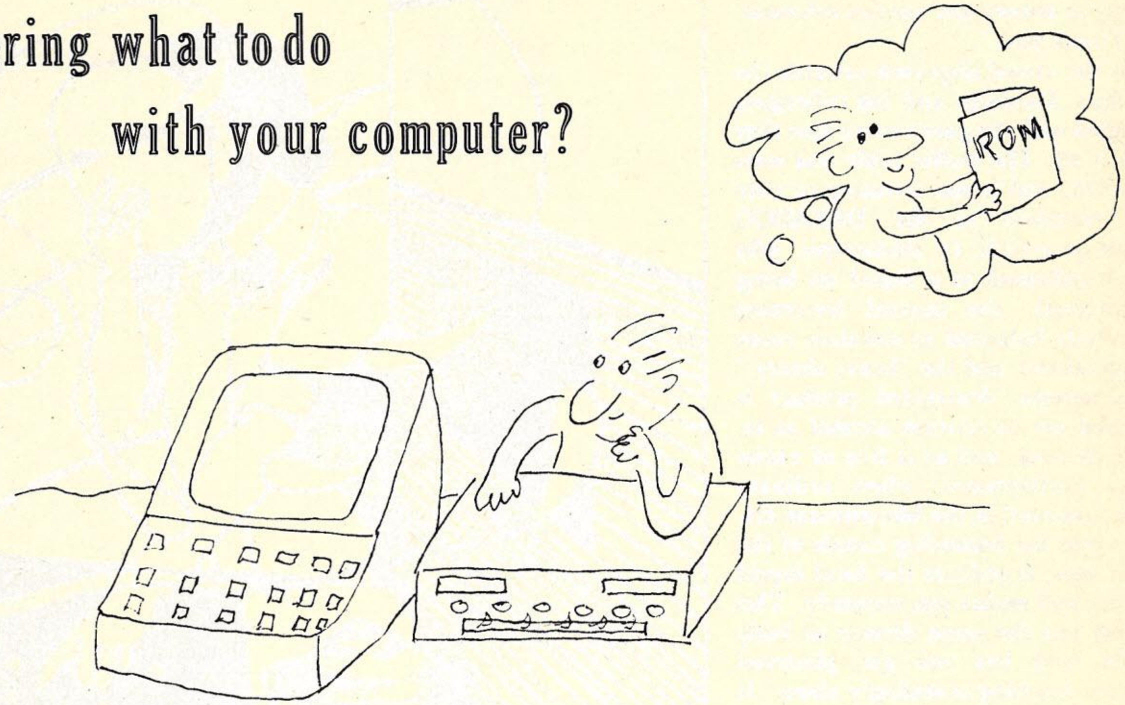
When the guests had sampled most of the delights on display, Daedalus banged his lead-azide loaded gavel for a terminal announcement.

"Thank you all for turning up" he said. "I hope you've seen that our research, while full of surprises, has no sinister motivations or objectives, but is carried along by the extreme entertainment value of trying to make things work and find things out. This is the underlying reason for the fascination of science, and I encourage my staff to enjoy it to the full.

"You'll find the usual brochures and P.R. bumph on your way out, so I'll just remind you that one of the secrets of our success is always to do the opposite of everybody else. When the other science-based companies were all expanding and recruiting a few years ago, we declined to overstretch ourselves and actively encouraged staff who had made their major contribution to move out and better themselves in the then-buoyant economy.

"Now that everyone else is cutting back like crazy, we are expanding from our conservative base, and are ready to welcome any turbulently creative characters who fear for their jobs in other organisations. I guarantee you'll have fun with us, but if you find it too overpowering, remember that you can always go back when the next boom comes along!" ▼

Wondering what to do with your computer?



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Digital Foam

the sexiest peripheral

by Bill Etra

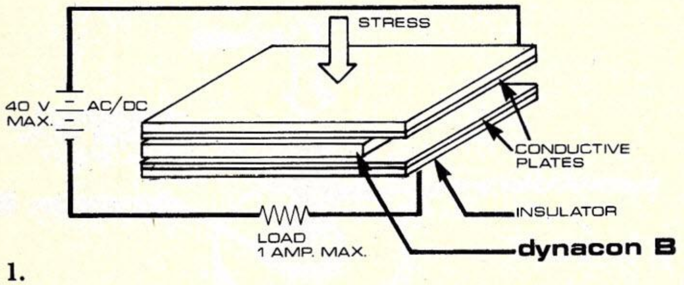

Figure 1.

Imagine a soft switch, one that can be bent, kneaded, or twisted in order to fit any application or configuration. One that can be worn as a glove to sense various contact points as your hands hold a pen or wrench, or as you knead dough. One that as a keyboard could be pinned to the underside of your lapel, allowing you to calculate odds while appearing only to be fingering your jacket nervously, sitting by the blackjack tables in Las Vegas. One that could be pressed beneath the window as you close it, and which in turn would alert your computer when the window was opened. Imagine that and hundreds of other applications for soft control, and you have Dynacon, the digital foam the rumor mills have been bouncing back and forth for years—the only difference now is that it's here.

Dynacon Industries has just released four types of electro-conductive rubberlike materials. These can be used, either as a single sensor or in combination with each other, to feed more complex perceptions to your computer. At last the computer can begin to feel the tactile world upon which so much of human information gathering is based. A whole new era of tactile/machine/computer feedback is about to evolve.

Basically the material makes a good electrical insulator—until it's squeezed. Then it becomes a conductor. This squeeze-release cycle can be repeated indefinitely, with the material going from high resistance (10 Megohms) to low resistance (less than one ohm).

The current flow can be localized. If the pressure is applied only to one point, by the use of a pencil for example, only that point becomes conductive. Although the resolution is not yet quite fine enough to permit the material's use in something like a signature-verification pad, where one would sign in and the computer would recognize the signature, it is fine enough to permit its use in coarser graphic displays. A one-inch-square piece of Dynacon can accomodate approximately fifty separate switching points to give a reasonably good resolution on a screen such as Cromemco's Dazzler. Sort of dot-to-dot squares is the way it would look.

Dynacon A is a linearly conductive material whose primary use is as an electrode for the other materials. Using the conductive foam in which integrated circuits are packed to prevent static-electricity damage also works well. Sandwiching Dynacon B or C between two layers of such conductive foam permits you simply to clamp on alligator clips in order to make contact.

Dynacon B is a quick-switching material ideally suited for digital applications such as touch-sensitive keyboards, multi-sensor burglar alarms, and individual-device-removal protection. By stationing a piece of equipment, such as a typewriter, on the foam, a circuit is completed, so if the equipment is removed the circuit is opened and the computer notified.

I have tried two input devices with Dynacon B. Processor Technology's 3P + S, which has logic voltage output, may replace the voltage source in all the diagrams (See Figures 1-4). It also has multiple-latched parallel-line inputs and outputs, and is ideal for interfacing with the B material. The

How about touch-sensitive keyboards or multi-sensor burglar alarms?

ROMtutorial ROMtutorial

Quick-switching material: *A material whose change in conductive property occurs very rapidly and with a light amount of pressure.*

Multiple-latched parallel-line inputs: *Inputs to a device consisting of several wires which carry electrical signals at the same time. The signals can change rapidly, but are "frozen" by electronic "latch" circuits so that the information can be picked up by the computer when it gets around to it.*

7A+D I/O: *An input-output board for S-100 computers having seven analog inputs which can be sampled and converted to digital information for use by the computer. The board has one reverse channel, in which digital information from the computer is converted to an analog voltage.*

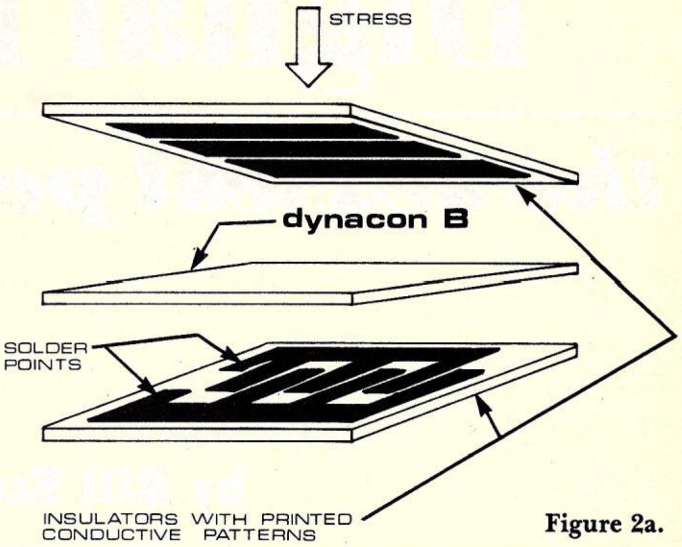

Figure 2a.

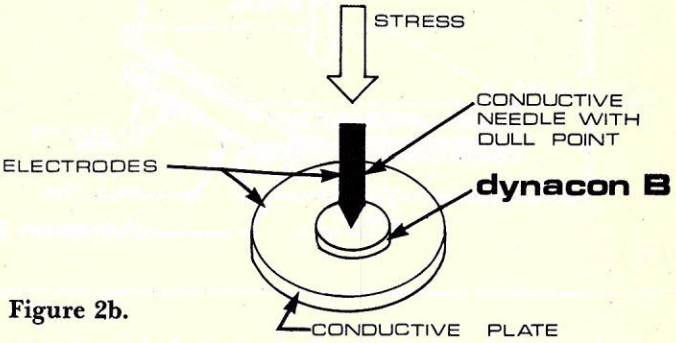

Figure 2b.

With a Dynacon glove and a vocal interface, the dumb could begin speaking.

second device I tried, Cromemco's 7A+D I/O, is less useful for interfacing the B material. However, as an interface for Dynacon C and the soon-to-be-released Dynacon D, it is excellent. By leading the connectors from the foam through a decoder, the C or D material can be inexpensively interfaced with the computer through Cromemco's 7A+D I/O which allows for several channels of eight-bit analog-to-digital conversion.

Dynacon C and Dynacon D are pressure sensitive. Conductivity varies with pressure. This means pressure alarms which ignore lightweight objects (like family pets or children, for instance) can readily be built. As can pressure-sensitive music keyboards where variation in pressure controls the volume. If variation in pressure also controls pitch, a whole new form of music might evolve. Another development, probably less than a decade away, is a glove made of Dynacon. With a Dynacon glove and a vocal interface, the dumb could begin speaking. Using the movement of the hand to trip the numerous soft switches in the glove, the vocal interface could be directed to verbalize for them.

The construction of an x-y joy stick emulating pad also becomes possible.

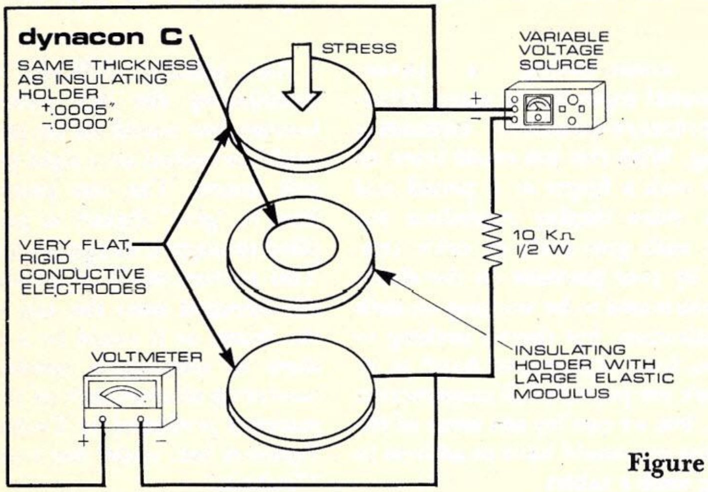
dynacon C
SAME THICKNESS AS INSULATING HOLDER
+.0005"
-.0000"
STRESS
VARIABLE VOLTAGE SOURCE
+
–
VERY FLAT, RIGID CONDUCTIVE ELECTRODES
10 KΩ
1/2 W
INSULATING HOLDER WITH LARGE ELASTIC MODULUS
VOLTMETER
+
–

Figure 3.

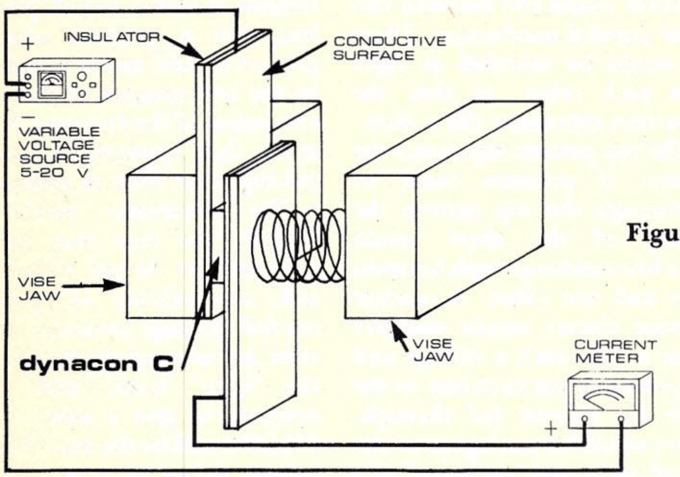
+
INSULATOR
CONDUCTIVE SURFACE
–
VARIABLE VOLTAGE SOURCE 5-20 V
VISE JAW
dynacon C
VISE JAW
CURRENT METER
+

Figure 4.

The mechanical malfunctions of the stick itself could be eliminated and anything from a pencil to your fingernail could be used as a scribe.

Dynacon is truly a new product in search of application. And the implications of its application could be more than a little startling. ▼

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X-Y joy stick emulating pads: *An x-y joy stick is a lever which normally stands straight up, but can be moved out of vertical in any direction. The x direction is along the right-to-left line, and the y direction is along the forward-to-back line. A computer hooked to a joystick could move a spot anywhere on a TV screen in response to the stick deflection, just as it could move that spot in response to a finger moving on a pressure-sensitive pad.*

DIGITAL FOAM CONTEST

All right, now that you know how Dynacon works, let's see you bounce *ROM* some good ideas on what to do with it. Besides our regular payment to contributors, we will be giving away two prizes for the best applications articles on digital foam we receive before January 1, 1978. That should give you plenty of time to come up with some good ideas and implement them.

First prize is your choice of $500 or its equivalent in Dynacon—that's enough Dynacon to cover a king-sized mattress. Second prize is $250 or enough Dynacon to cover your half of the bed.

The articles should be 1,500-3,000 words long. They should include diagrams (roughs are fine) and if possible photographs of your system in operation. You must be able to demonstrate that you have it up and running.

Remember, the entries are to be postmarked no later than January 1, 1978. So put on your Dynacon thinking cap right now.

PADDED FOAM by Lee Felsenstein

Try constructing a three-dimensional input tablet using Dynacon pressure-sensitive elastomer sheeting. With this you could trace an outline with a finger or a pencil and have a video display reproduce the outline with grey-scale or color controlled by your pressure on the sheet. Bell Labs is said to be working on such an application, but there's nothing to stop you from trying your hand at it. We can't yet provide full construction details, but we can lay out some of the problems you would have to address in making such a tablet.

The principle of operation would be that the sheet would rest between two patterns of parallel conductors. These patterns would be oriented at right angles to each other, so that the bottom pattern represents the x direction and the top pattern represents the y direction. If pressure could be applied through the top pattern the conductivity of the sheet would establish a low-resistance path between one x-line and one y-line. A counter and decoder circuit would energize one line at a time with a voltage and would sequentially test each line on the other side for current fed through. This action would be analogous to the vertical and horizontal "sweeping" of a TV raster. An analog-to-digital converter (A-to-D) would convert the current level to a binary number, which would be made available to the computer interface along with the numbers representing the x and y coordinates.

The primary difficulty would be establishing the line patterns. The bottom one would be no problem; it could be etched on a rigid printed circuit board. The top pattern would have to "give" slightly as pressure applied through it compressed the foam. This pattern could be conductive ink silk-screened onto the top surface of the foam, or it could be a laminated sheet of alternating conductive and insulating silicone such as the "Zebra" material produced by Technical Wire Products Inc. under the trademark of "Tecknit."

Electrical connection to the top flexible material would pose a problem, but a pressure contact to a printed circuit board would probably be the best solution to that. The slow relaxation of the Dynacon sheet might make that impractical, though, requiring some form of cement.

The electronics would not be critical, but care may have to be exercised in design where accuracy and repeatability of position are needed. Voltage levels out of TTL devices are notoriously unpredictable in the "high" level; that logic was designed to give a solid "low" only. CMOS would be the best choice for the voltage driver to scan the sheet. A CMOS analog multiplexer like the 4051 would be an obvious choice for the scanner on the receiving side. CMOS is designed to work with low levels of current (typically 400 microamperes) and some effort may be necessary to scale down the sensitivity

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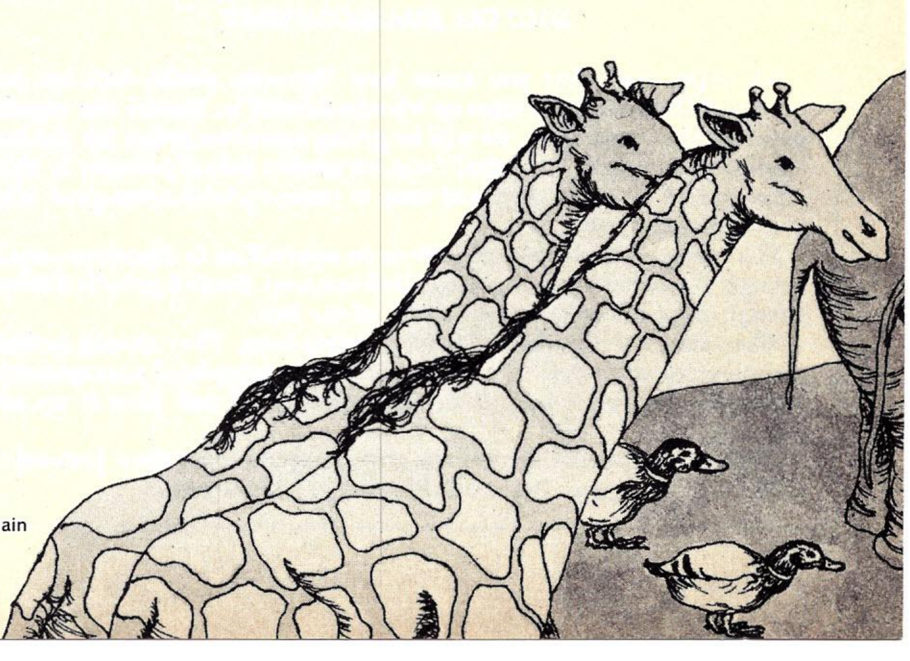
Raster: *A regular pattern used to sample a flat surface. The grid of lines on a TV screen is a raster.*

Analog-to-digital converter: *An electronic device that looks at a voltage which can have a range of different values and converts it to a code consisting of digital on-or-off signals.*

Interface: *The boundary between different sections of a computer, or between the computer and the outside world. The circuitry which crosses the boundaries is also called the interface.*

TTL: *Transistor-transistor logic. One of several kinds of electronic circuits which can be hooked into digital integrated circuits. Each kind has its advantages and weaknesses. TTL is the dominant digital circuit used today.*

CMOS analog multiplexers: *CMOS (Complementary Metal Oxide Semiconductor) is another kind of electronic circuitry used in integrated circuits. It is "softer" and slower than TTL and can be used in analog functions where the signal is not just on or off. A multiplexer is a circuit which selects one of several inputs and connects it to an output. An analog multiplexer handles analog signals, and behaves like a digitally controlled switch.*



Cindy Hain

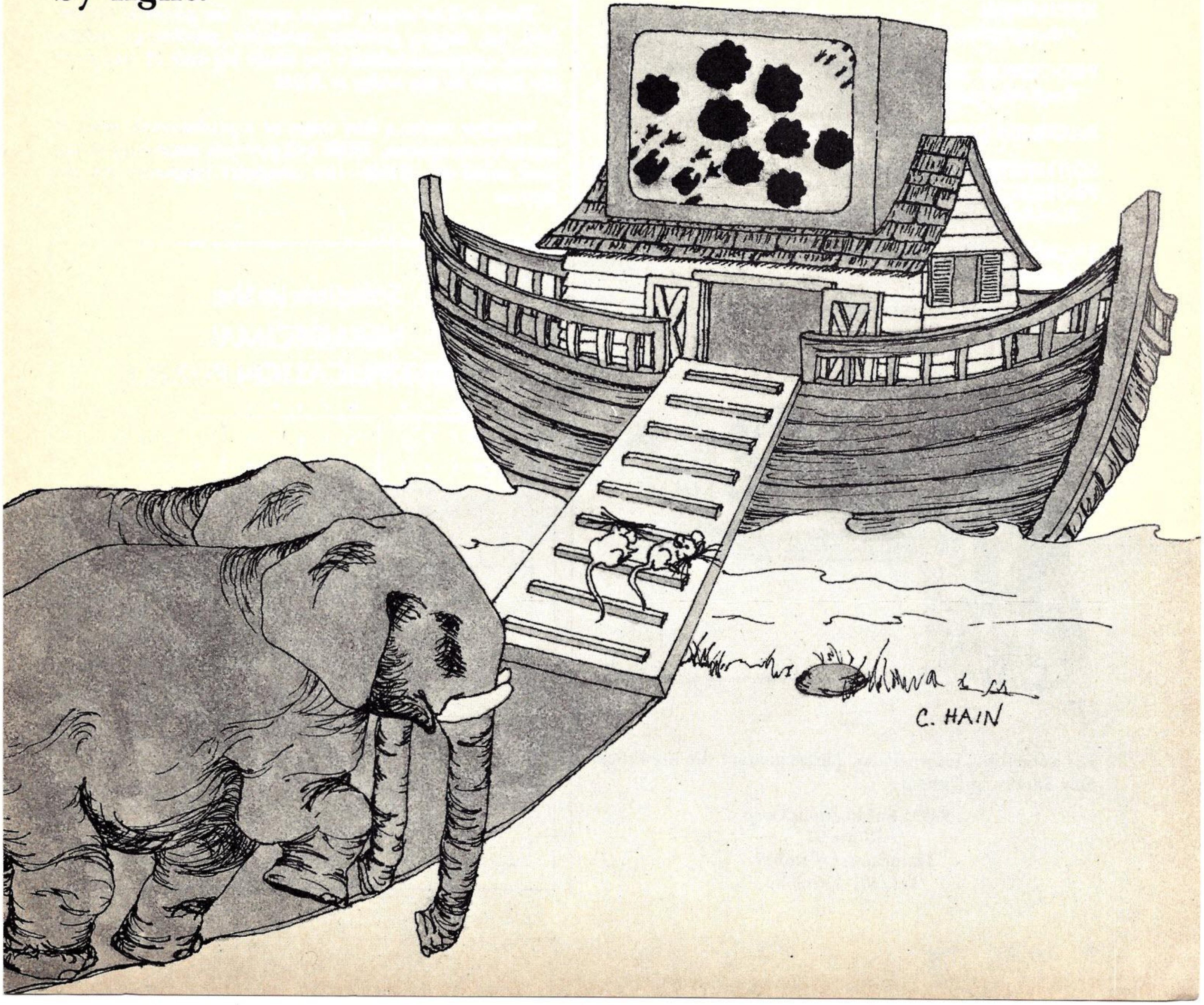
of the resulting circuit.

A hardware scanner would consist of counters and decoders (the two are combined in the CMOS 4017 and 4022 devices) which would increment until the receiver detected a current of greater than a leakage-minimum level. Then it would stop until the interface circuitry had read out the x, y, and z (pressure) values. Scanning would then continue. More elaborate strategies would be possible if the counters were replaced with registers which latch x and y values provided from the computer. With this scheme the tablet could test the immediate area around the last pressure point to track with a rapidly moving pressure event.

One highly interesting point remains to be mentioned; Dynacon sheeting is sensitive to light and other electromagnetic radiation. It will retain a conductivity profile impressed on it by light for the time that it remains stressed. This time is not infinite, since the foam relaxes under pressure. But if the top conductive pattern is transparent, the foam might be made to read out a digitized grey-scale representation of a picture which is projected onto its surface while under stress. The picture could be "cleared" by a momentary removal of the stress.

Dynacon materials kits are available from Dynacon Industries, Inc., 14 Bisset Drive, West Milford, N.J. 07480 for $10 if you send your check with your order, or for $12 if they have to bill you.

Dynacon sheeting will retain a conductivity profile impressed on it by light.



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From p. 40

Solution to the HEXADECIMAL MULTIPLICATION PUZZLE

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A										64	6E	78	82	8C	96
B											79	84	8F	9A	A5
C												90	9C	A8	B4
D													A9	B6	C3
E														C4	D2
F															E1

WINDOWS TO PSYCHOLOGY

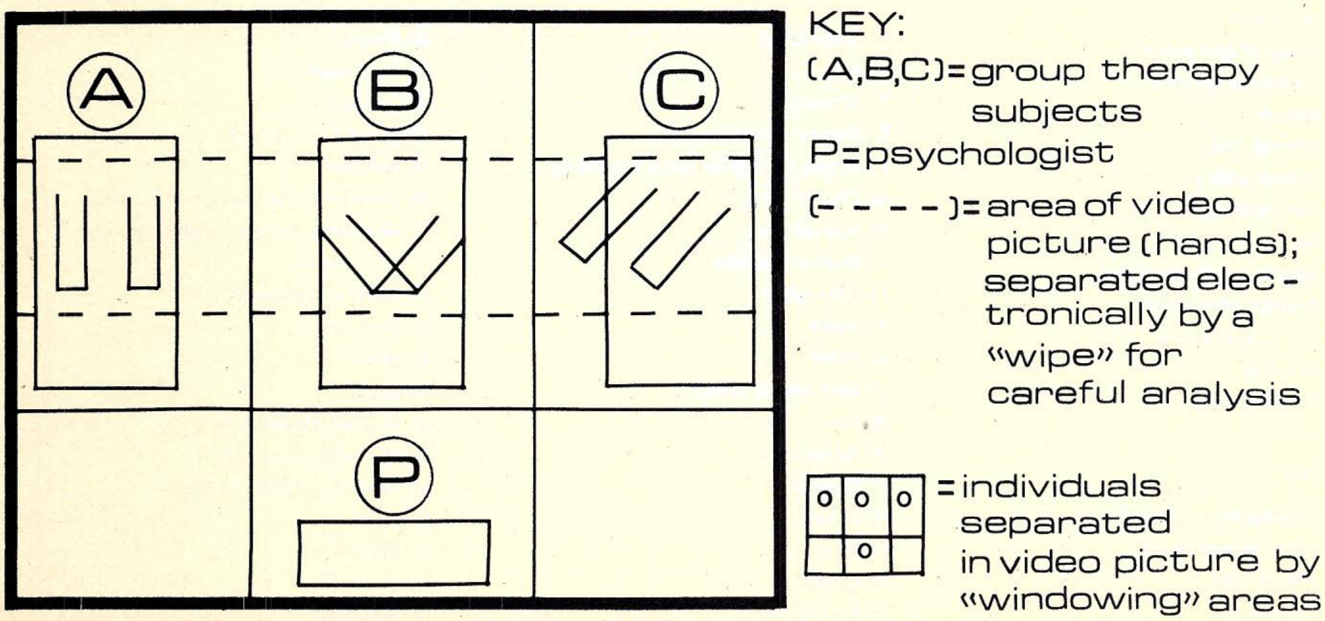
by Bill Etra

Ever since psychology began to be a field of scientific inquiry, psychological data has been looked upon by researchers in other areas of biological science with varying degrees of distrust. This is not due to questioning of the importance of psychology or the discoveries made in this area, which are recognized as vital contributions to science. The problem lies in the subjective quality of psychological findings. Psychological experiments, especially those dealing with human subjects, tend to result in a set of interpretations developed by the therapist based on his or her data. Without the hard mathematical formulas and proofs which grace the efforts of other scientific researchers, the psychologist is often unable to validate the findings of these experiments.

Many psychologists have turned to videotape technology in order to record human interaction. This technique is most beneficial when groups of people are involved. As a method of image storage it is helpful to psychologists because the data to be analyzed can not only be studied by researchers not necessarily present during the original interaction, but viewing of the tape can take place repeatedly, at any time, or it can even be still-framed for more careful study.

One problem with this method is that it takes several hours of careful viewing to obtain a large body of data from a single hour of videotape. Other problems arise because information obtained in this manner is still subject to the particular bias and interpretation of the researcher studying the tapes.

My proposal is to use the videotape method of storing data involving human interaction in a different way. In its most basic form, a videotape can be viewed as the relationship of light and dark areas over a time span, with an accompanying audio recording on the same tape. Assuming a stationary camera position, one can use the standard video technique known as a "wipe" (see illustration) to separate a single individual from the group. By "windowing" or electronically separating out the area of the video frame containing the individual (or part of the individual—head, hands, etc.) and using simple A to D conversion, one can now obtain a measure of the person's gross motion over time. This deviation in position of brightness from one video field to the next gives the researcher real hard data to analyze. Combined with measurable changes in voice modulation over time, indicating which individual is speaking, the order of individuals speaking, and changes in the individual's voice characteristics such as pitch, speed, or loudness, comparisons can now be made which are more analytical in nature. The figures for gross motion over a time (for each of the several individuals) can then be compared to tests done by pattern recognition of the audio portions of the videotape. Computer analysis of this kind can, in turn, help to formulate a data base from which we can begin to develop objectively based theories about human interaction. Psychological observations can at last be quantified in a manner fulfilling the basic requirement of scientific validation—that the experiment be both repeatable and available for verification by the researcher's peers. ▼

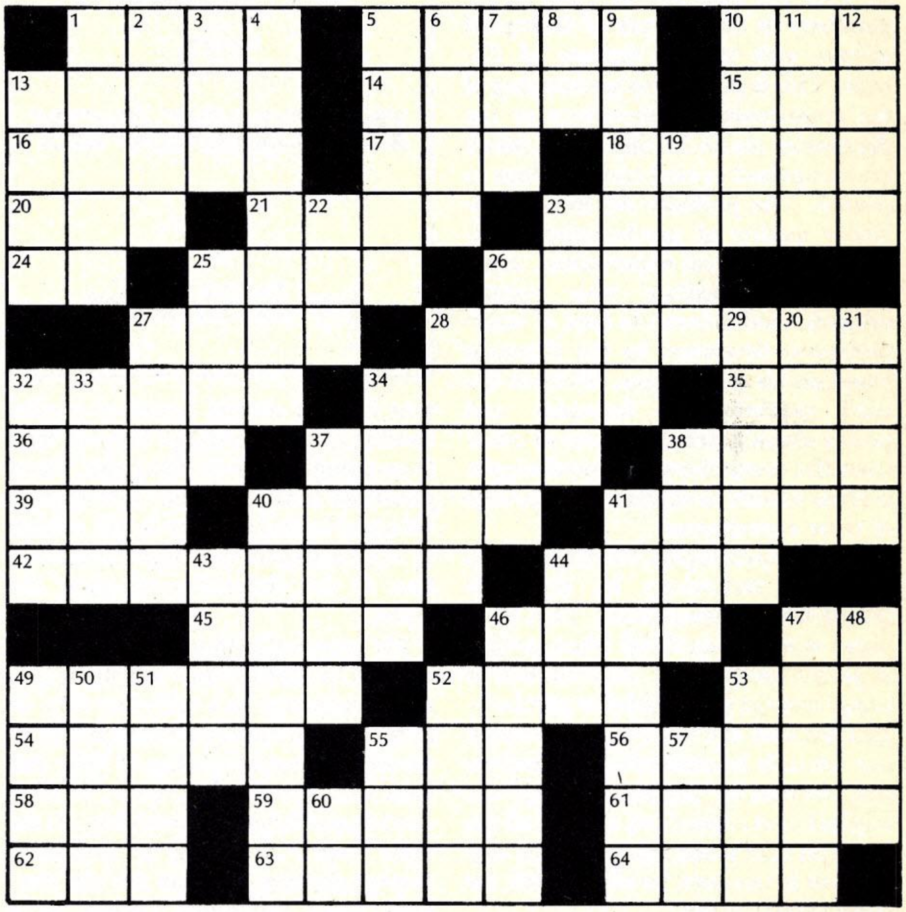

A
B
C
P
KEY:
(A,B,C)=group therapy subjects
P=psychologist
(- - - -)=area of video picture (hands); separated electronically by a "wipe" for careful analysis
o o o
o
=individuals separated in video picture by "windowing" areas

PROMpuzzle

Daniel Alber

ACROSS

1 *Decreased signal power in decibels*
5 *Program, ______ alone*
10 *Male cat*
13 *Cuba ______*
14 *Cost*
15 *______ digit adder*
16 *Hamburger garnish*
17 *Of us*
18 *Spear*
20 *Presidential nickname*
21 *Father*
23 *Describing desired computer language*
24 *Solid State* (abbr.)
25 *Primary computer in a multiple operation*
26 *Comedienne Martha ______*
27 *Bait*
28 *System component that reconstitutes signals*
32 *Nomads*
34 *Boxed*
35 *Respect*
36 *Type of computer memory*
37 *Attempts*
38 *Winter vehicle*
39 *Play division*
40 *Shore*
41 *Performers*
42 *Time between inquiry and output*
44 *Children*
45 *Poems*
46 *Prefix denoting* 10^6
47 *Arctic gulf*
49 *Group of four pulses*
52 *Antoinette for short*
53 *Mature*
54 *Fencing foils*
55 *Torque* (abbr.)
56 *Data ordering on*
58 *Stir*
59 *Magnetic recording heads*
61 *Austrian psychiatrist*
62 *______ key* (abbr.)
63 *Ill fitting*
64 *Robert E. et al*



The solution to this PROMpuzzle will appear in next month's *ROM*.

DOWN

1 *Subprogram connections*
2 *Off-Broadway award*
3 *Theatre sign*
4 *Transducers*
5 *Team effort*
6 *Real*
7 *Broadcast*
8 *Noise criterion* (abbr.)
9 *Access held up by batch processing*
10 *Chinese gang*
11 *A single time*
12 *Boolean operator*
13 *Girl's name*
19 *Space*
22 *Belief*
23 *Data storage devices*
25 *Bum*
26 *Adjust anew*
27 *Drifts in*
28 *Elevate*
29 *Yarns*
30 *Pitcher*
31 *Russians* (sl.)
32 *Distant*
33 *Food staple*
34 *Uncouth*
37 *Healthy as a muscle*
38 *Soft drink*
40 *Conference that developed COBOL*
41 *Describing discrete integral numbers*
43 *Skin opening*
44 *Realm of knowledge*
46 *Code name*
47 *Stares*
48 *Lager*
49 *Weather abbreviation*
50 *Of major proportions*
51 *Type of computer editing*
52 *Digits*
53 *Talented*
55 *Boxing term*
57 *Fruit drink*
60 *______7, James Bond*

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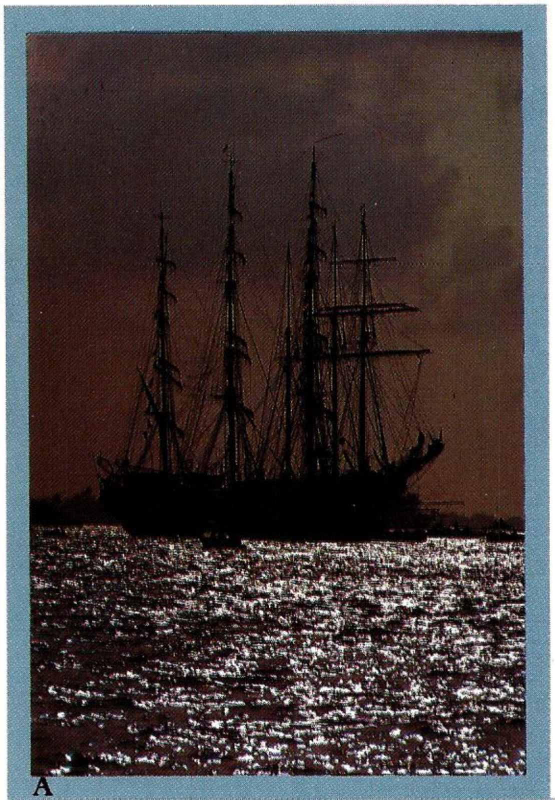
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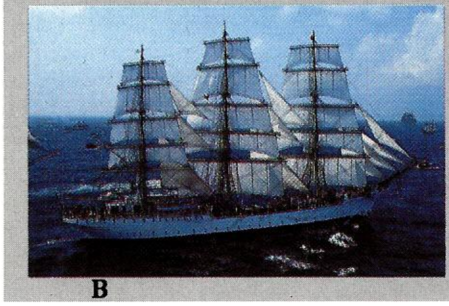
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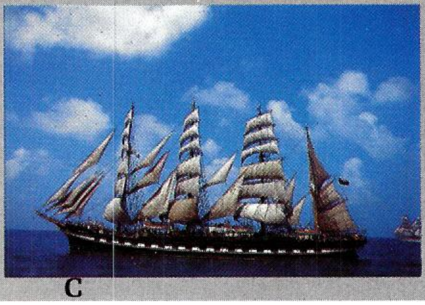
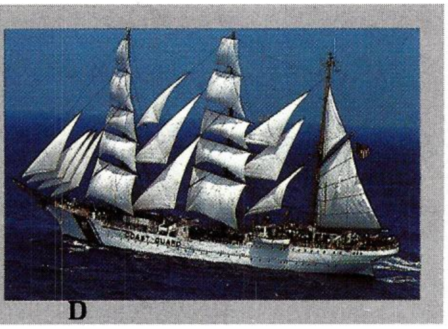

C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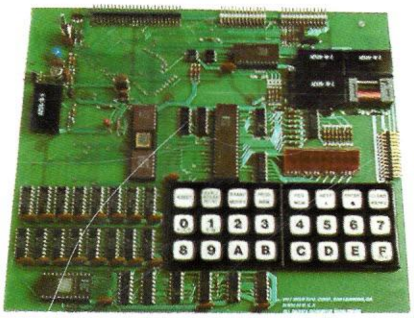

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